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July 1999
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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Standard Ship Test and Inspection Plan, Procedures and Database

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
National Steel and Shipbuilding Company
San Diego, California

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DISCLAIMER

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

NSRP 0534 Project 6-95-1

Prepared For:
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Panel SP-6 Marine Industry Standards

Submitted On:
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Abstract

The standards and specifications that the U.S. shipbuilding industry must follow are often inconsistent and sometimes inadequate. These standards and specifications are contained in numerous reference sources and are enforced by multiple regulatory bodies, classification societies, government agencies and owners. Although shipbuilding technology has continued to make significant improvements that have reduced portions of design and construction manpower requirements, one area that is contributing to expanding construction schedules and increased cost is the area of test and inspection. This project investigates existing rules and regulations for testing and inspection of commercial ships and identifies differences and similarities within the requirements. The results include comparison matrices, a standard test plan, a set of standard test procedures, and a sample test database developed for a typical commercial ship.

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Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Task 1 - Collection and Review of Standards and Specifications

NSRP 0534 Project 6-95-1

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Introduction/Abstract

The standards and specifications that the U.S. shipbuilding industry must follow are often inconsistent and sometimes inadequate. These standards and specifications are contained in numerous reference sources and are enforced by multiple regulatory bodies, classification societies, government agencies and owners. Although shipbuilding technology has continued to make significant improvements that have reduced portions of design and construction manpower requirements, one area that is contributing to expanding construction schedules and increased cost is the area of test and inspection.

Successful testing of various systems, equipment, machinery, fittings, and components is required prior to delivery. Most of these required tests are performed during the final stages of construction, on board, after launch. As with outfitting, test and inspection during the final phases of construction can be inefficient, time consuming, and costly. As a result, test and inspection can preclude attempts to reduce the duration of ship construction time.

The overall ship construction time and associated cost would be significantly reduced if the system testing were accomplished in the most efficient stages of construction, which may be either earlier or later in the build strategy. Standardized procedures for typical tests and inspections would eliminate costly owner interpretations of CSARB (classification society and regulatory body) requirements. Such standardization may also reduce the amount of repetitive testing and could be facilitated by a database that incorporates the acceptance of systems and equipments at the vendor, ground assembly, onboard outfitting, and trial stages of construction.

The report that follows represents the results of the first of six tasks required to develop a standard commercial ship test and inspection plan, procedures, and database. Task 1 is titled - *Collection and Review of Standards and Specifications.*

Objective

The first step of Task 1 was to compile a list of references, standards, and specifications used by domestic and foreign shipyards for certification, classification, and acceptance. The list of applicable documents is shown in Figure 1.

From the information gathered, all portions of the associated documentation that are related to shipboard testing were extracted and compiled. This information is classified into related categories as dictated by the various CSARBs. After a review of each section, a written document identifying inconsistencies, errors, conflicts, and discrepancies was prepared. This document is considered the deliverable portion of Task 1 and is included as Attachment B of this report.

Approach and Rationale

Upon preliminary review of the pertinent documentation, it was apparent that no two classification societies or regulatory bodies subdivide their rules and regulations in the same way. This makes a direct comparison difficult and often misleading.

For the purposes of this exercise, the team determined that the most effective and perhaps the clearest method of comparison is to establish a baseline. The baseline represents a selected set of rules or regulations from a single regulatory body or classification society. All other rules and regulations are then compared to the baseline set to determine inconsistencies and deficiencies.

Based on the information compiled, the team selected the **American Bureau of Shipping**

American Bureau of Shipping	*Rules for Building and Classing Steel Vessels*
Det Norske Veritas	*Rules for Classification of Ships*
Lloyd s Register	*Rules and Regulations for Classification of Ships*
American Society of Testing and Materials	*Volume 01.07 Shipping*
Code of Federal Regulations	*46 Parts 1 to End*
Safety of Life at Sea	*Rules*
Japanese Industrial Standards	*Section F*

Figure 1 - Collection of Standards and Specifications

(ABS) - *Rules for Building and Classing Steel Vessels* as the baseline set of rules. The ABS documentation subdivides their rules into five parts, and furthermore distinguishes between testing, tests, trials, and hull test & trials. This method of subdivision along with the comprehensive testing criteria of the ABS made their rules the most desirable when establishing a baseline. See Figure 2.

Although the ABS Rules were found to be the most comprehensive, there are certain systems or equipments for which the ABS Rules have no specific testing requirements. To supplement the ABS Rules, the requirements for testing of these systems and equipments covered by documentation from other regulatory bodies other were included in the comparison.

Additionally, while all sections pertaining to testing, trials, and inspection have been reviewed, not all sections are applicable to our project. Certain areas which deal only with manufacturer's testing, first article testing, component testing, in-service or periodic testing, and quality inspection are not considered germane to this project. The focus of our exercise is to compile information (rules and regulations) governing system testing, trials and inspection. Therefore more emphasis has been placed on those sections which pertain to system testing.

It should also be noted that the Society of Naval Architects and Marine Engineers (SNAME) Technical and Research Bulletins 3-47 *Guide for Sea Trials* and 3-39 *Guide to Shop and Installation Tests* were not considered applicable to this project. Although the SNAME documentation is relevant to the project, SNAME is not considered a regulatory body or a classification society, and therefore the information contained in the Technical and Research Bulletins is not included in the

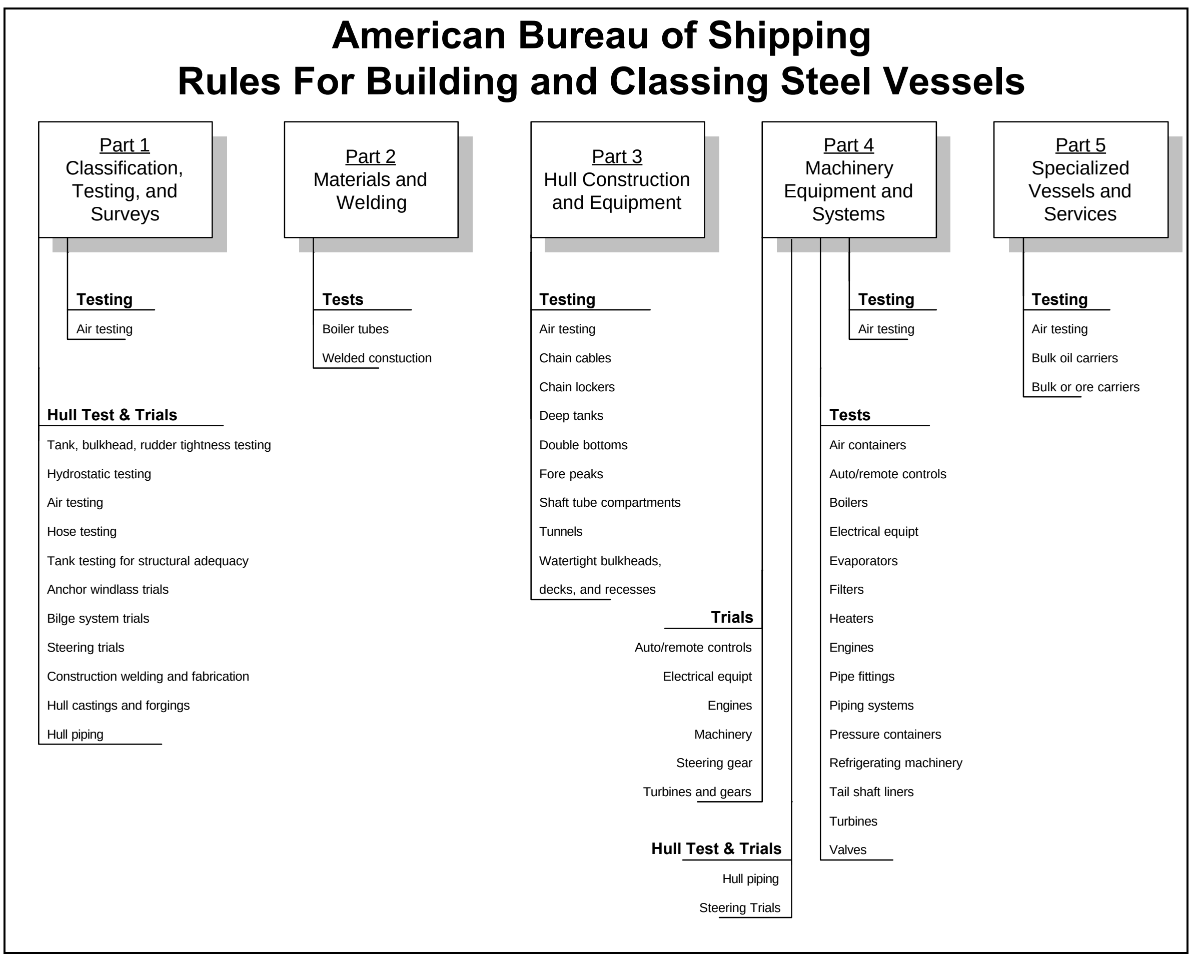

Figure 2 - Subdivision of ABS Rules

comparison matrix. The same is true for the American National Standard Institute (ANSI) - *IEEE Recommended Practice for Electric Installations on Shipboard*, and also holds true for the International Electrotechnical Commission (IEC) - *Electrical Installations in Ships, Part 401 Installation and Test of Completed Installation*.

Findings

As the first step toward identifying differences between regulatory body requirements, a matrix was created. The matrix compares stated test requirements of CSARBs with regard to categories based on ABS suggested subdivisions. The matrix is subdivided into approximately 72 categories. Of these 72 categories, 35 categories had CSARB references which were applicable to our project. These 35 groups make up the working portion of the matrix and are listed on the first 3½ pages of the matrix. The remaining 37 categories had references pertaining only to first article or manufacturer testing. These headings are grouped together at the end of the matrix in the shaded areas and will not be used in the comparison. In a parallel effort to the matrix review, copies of the matrix were forwarded to representatives from the applicable classification societies and regulatory bodies. Their input, as appropriate is included in the matrix. The matrix is considered a working document and a copy in its current form is included as Attachment A. After comparison and review of the applicable sections, similarities, differences, and inconsistencies within the associated testing requirements were compiled. A summary of these findings is included as Attachment B.

Results

The initial review of the test requirements of the various CSARBs has revealed that the differences between the requirements is not as extensive as the team had originally expected. There are many areas where one classification society or regulatory body appears to take on the lead role in development of a test standard. Conversely, there are certain categories of testing in which certain CSARBs have no clear testing requirements.

Applicability to Other Tasks

The document provided as Attachment B will serve as a guide for determining regulatory barriers that restrict testing to specific phases of construction, a consideration in Task 2. Attachment B will also be used as a reference guide for the development of the Standard Ship Test and Inspection Plans and Procedures of Task 3.

In order to gain CSARB approval of the Commercial Standard Test Plan and Procedures in Phase II of this project, it is necessary to develop plans and procedures that satisfy the requirements of all the CSARBs. Using the information compiled in Attachment B,. the objective of Tasks 2 and 3 is to design a Commercial Standard to accomodate all aspects of CSARB requirements.

Classification Society & Regulatory Body Test Requirement Comparison Matrix

Category	ABS	ASTM	USGG	Lloyd's	DNV	JIS
Division and Numbering Key	Part 1/ Section 1/1 Subsection 1/1.1 Paragraph 1/1.1.1	Section 1 Volume 01.07: F 111-91 (Spec. # - Year)	46 CFR 111.11-1 Part, Subpart, Sect. MSM - Marine Safety Manual NVIC	Pt 1, Ch 1, Sec 1.1 (Part, Chapter, Section)	1.1-1 (Part.Chapter-Page)	JIS F: 111-91 (Standard # - Year)
Anchor Windlass, Cargo & Mooring Winches - Trials	1/2.3			Pt 3, Ch 13, Sec 7.6		6714-95, 6709-85
Automatic / Remote Controls and Monitoring Systems	4/11.3.11c, 4/11.5.15, 4/11.7.2, 4/11.7.16, 4/11.9.14, 4/11.11.5		(62.30-10, 61.40) ~~(61.05, 63.15-9)~~	Pt 6, Ch 1, Sec 7	4.5-4, 6.5-3, 6.3-15	0803-79 0804-79 0805-79 0806-79
Azimuth Thrusters and Thrusters	4/1.15 refers to Guide for Thrusters and Dynamic Positioning Systems	~~(F 841-84)~~		Pt 5, Ch 20, Sec 6	4.2-47	
Bilge systems trials	1/2.4					
Boilers - Hydrostatic Tests	4/2.39, 2/2.15, ~~4/2.23, 4/2.37.1-.53~~		(52.01-135) - Refers to PG 90-100 of ASME ~~MSM 6.H~~			
Bridge equipment					6.8-43	
Cranes, Davits	Guide to classification of Cranes					2104-87 2103-87, Refer to classification society
Electrical Equipment, Electric Propulsion Testing and Trials	4/5.21.2, 4/5D2.19, 4/5B3.3, ~~4/5B7.7.2c~~, 4/5C, 4/5D1.9.3f, 4/5D1.11.2i, 4/5D2.11.3, ~~4/5D2.17.1~~, ~~4/5D2.17.9b~~ 4/5D2.17.9c,		MSM 6.L, ~~NVIC 2-89,~~ 110.30 - Refers to ABS Rules	Pt 6, Ch 2, Sec 20.2 - Electrical Testing and trials Pt 6, Ch 2, Sec 20.3	4.4-66, 4.4-55, 4.4-62	

Classification Society & Regulatory Body Test Requirement Comparison Matrix

Category	ABS	ASTM	USGG	Lloyd's	DNV	JIS
	4/5D2.17.12e, ~~4/5A2.1, 4/5A3.1, 4/5A4-10~~					
Elevators	Guide for Construction of Elevators	(F 916-85)				
Fire Detection Systems	Sections 4/9.37.1, 4/9.40.1, 4/9.71, 4/11.7.15c, 4/11.9.12 address systems, but not testing	(F 1198-92)				
Fire Extinguishing Systems	~~4/9.5, 4/1.13, Table 4/1/1, 4/9.13, 4/9.15, 4/9.19-73~~		NVIC 6-72			
Fluid Power and Control Systems, and Controllable Pitch Propellers	4/6.22.2, 4/8.9.5g, 4/7.11		(58.30-35)		4.2-42-44	
Hull monitoring system					6.11-7	
Incinerators		(F 1323-90)				7011-89
Inert gas systems	Survey 1/3.24, controls 4/11.17, general 4/6.72.11			Pt 5, Ch 15, Sec 7.8		
Internal Combustion Engines	4/4.43, 4/4.45, ~~4/4D~~			Pt 5, Ch 2, Sec 9	4.2-5	0404-85, 4304-94
Ladders		~~(F 840-83)~~				~~2615-82, 2617-89~~, 2621-85, 2622-85
Lifesaving appliances, Lifesaving equipt.			(~~199.03~~, 199.40, 199.45)		3.6-2	
Loading computer system					6.9-3	
Machinery	4/1.11		58 - Refers to ABS, ~~MSM 6G, .I~~			
Noise	Guidance Notes on Application of		NVIC No. 12-82, Enclosure 3		5.12-4 - Refers to ISO 2923, and	0905-81, 0904-81

Classification Society & Regulatory Body Test Requirement Comparison Matrix

Category	ABS	ASTM	USGG	Lloyd's	DNV	JIS
	Ergonomics to Marine Systems		58.01-50 ~~MSM 6.P.9.d~~			
Piping Systems	4/6.7, 1/2.8, 4/6, 4/6.15.3, 4/6.15.3, ~~4/6.14, 4/6.17, 4/6.19, 4/6.65, 4/6.67, 4/9.7~~		56 and 96.03-1	Testing - Pt 5, Ch 12, ~~Sec 5.8~~ Hydraulic Testing - Pt 5, Ch 12, Sec 7		
Pressure Containers (Evaporators, Filters, etc.)	4/2.39, ~~4/3.27~~(see turbines)		54, 54.10, ~~61.10~~(in service), ~~50.30, MSM 6.Q~~	Pt 5, Ch 10, Sec17		
Reduction Gears	4/3.29.8				4.2-28	
Redundant propulsion	Guide for Propulsion Redundancy, Section 11				6.2-2	
Refrigerating Machinery and Refrigerated cargo installations - Acceptance trials	4/12.45, 4/12.47		(58.20-25)	Pt 6, Ch 3, Sec 5	5.10-21	
Shafting - Alignment, and Torsional Vibration	4/7.33.6, 4/7.33.3				4.2~~-30~~ and 41	
Stability test / Inclining experiment		(F 1321-92 (01.07))			3.4-10	
Steering gear and Rudders Trials	4/8.13, ~~4/8.7, 4/8.9.6,.7~~		MSM 14.B	Pt 5, Ch 19, Sec 7	3.3-24	0809-91
Tank Testing, Bulkhead and Rudder Tightness testing, Hydrostatic Testing, Tunnels, Vapor overpressure, Air Testing	1/2.2, 1/2.1, Table, 1/2.1.2, 3/7.23, 3/13.11, 3/19.11.5, 3/12.13, 3/19.11, 5/2B.13, 5/2A.1.7,		gasoline (58.50-5(c)), and diesel (58.50-10(c)) (72.01-25 passenger ships) ~~(38.05-3)~~, 39.20-11	~~Pt 1, Ch 3, Sec 6.5, 7.5, 8.5~~ Periodic surveys only	5.5-39, 3.1-4, 3.1-85	
Trials, Inspection and Sea Trials	~~4/3.39, 4/1.11, 4/4D, 4/11.7.16~~ All covered in other		58.01-30, 31.10-40	Pt 5, Ch 1, Sec 5 Pt 3, Ch 1, Sec 8.3.8		0801-89

Classification Society & Regulatory Body Test Requirement Comparison Matrix

Category	ABS	ASTM	USGG	Lloyd's	DNV	JIS
	sections					
Turbines	4/3.27, 4/3.39,	(F 975-86) Steam		Steam - Pt 5, Ch 3, Sec 6 Gas - Pt 5, Ch 4, Sec 6	Steam turbines 4.2-13, Gas Turbines 4.2-17, 4.2-28	Steam 4201-89
Vibration					5.12-5 (vib)	0907-90
Watertight bulkheads, decks, and recesses (hose testing)	3/12.13, 1/2.1.4		MSM 6F5.f	Pt. 3, Ch. 1, Sec 8.3 Table 1.8.1		
Welded construction	2/3C.1.2 to 2/3C.7				2.3-1	
Air conditioning - Classification, First article testing		(F 1433-94)				
Anchors - Material testing and Inspection	2/1.11.1 to 2/1.13.11					3301-90
Approval inspections and tests for manufacturers			(159.005-9)			
CO2 Extingushing piping, Cargo and Misc. Vessels Passenger ship CO2 extingushing equipt	Refers to SOLAS Chpt II-2, Regs 5.1 & 5.2, but no reference to testing		(95.15-15) (76.15-15 - passenger ships)			
Tanks containing dangerous cargoes in bulk - Cargo and Misc. Vessels - In service testing			(98)			
Cargo Hooks - manufacturers proof load testing			31.10-16			2105-90
Centrifugal pumps - manufacturers unit performance testing		(F 998-86)				
Compressors - Workshop testing					4.2-50	

Classification Society & Regulatory Body Test Requirement Comparison Matrix

Category	ABS	ASTM	USGG	Lloyd's	DNV	JIS
Chain cables, Chain Lockers- Manufatcurer's pull testing	3/12.13			Pt 3, Ch 13, Sec 7.7	3.3-31	3303-93, 2106-88
Dehumidifiers First article and manufacturers testing		(F 1075-94)				
Electric cables testing. - Manufacturers testing				Pt 6, Ch 2, Sec10.2		
Electric transformers - Static convertors - manufacturers tests					4.4-40	
Electrical Rotating machines Manufacturers testing				Pt 6, Ch 2, Sec 8.8 Survey and testing	4.4-35	
Electrical Switchgear and control assemblies testing Manufacturers testing				Pt 6, Ch 2, Sec 7.18		
Freight securing devices - Proto type and production testing				Pt 3, Ch 14, Sec 3.4		
Fuel oil blending System						7010-85
Fuel oil meters - manufacturers quality and production tests		(F 1172-88)				
Fueling hose reels- manufacturers testing		(F 1347-91)				
Gears - Manufacturers test and inspection requirements					4.2-25	
Hull castings and forgings	1/2.7, 2/1					
Marine portable tanks and cargo handling systems - Periodic inspection and test			Subpart E (64.77)			
Mechanical seals - Manufacturer's testing		(F 1511-95)				
Overhead Travelling crane						0802-89 - shop test

Classification Society & Regulatory Body Test Requirement Comparison Matrix

Category	ABS	ASTM	USGG	Lloyd’s	DNV	JIS
Specifc tests and inspections - Passenger ship			(71.20-20)			
Preapproval review - for materials and equipment			(159.005-7)			
Pressure reducing valves - Manufacturers Production testing		(F 1565-94 AND 1370-92)				
Purifiers						6601-89, 6602-79 - shop testing
Rotary positive displacement pumps - Manufacturers performance tests		(F 1510-94)				
Spill valves - manufacturers production and prototype tests		(F 1271-90)				
Steam traps - Manufacturer’s production testing		(F 1139-88)				
Turbo-charger type tests				Pt 5, Ch 2, Sec 10	4.2-48	
Warping heads, capstans - manufacturer’s testing		(F1106-87)				
Watertight door assemblies (sliding) - manufacturer’s testing		(F 1196-94)				
Watertight doors - Manufacturer’s testing		(F 1069-87)				
Wildcats, ships anchor chain, test fit		(F 765-93)				
Wire Ropes - Pull testing					3.3-37	

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Task 1 - Collection and Review of Standards and Specifications

Anchor Windlass, Cargo and Mooring Winch Trials

The ABS, Lloyd's, and the JIS all have specific requirements for the testing of anchor windlasses, and the JIS also has specific requirements for testing of winches. Differences and similarities in the testing requirements of these agencies are outlined in Table B-1.

ABS requires each anchor windlass to be tested under normal working conditions to demonstrate satisfactory operation. Each unit is to be tested for braking, clutch functioning, power lowering, hoisting, and proper riding of the chain through the hawsepipe, over the wildcat, through the chain pipe, and stowing in the chain locker. Also it must be demonstrated that the windlass is capable of lifting each anchor with 82.5 m (45 fathoms) length of chain submerged and hanging free. Where the available water depth is insufficient, a proposed test method will be considered.

Lloyd's requires the anchor windlass to be able to lift the anchor from a depth of 82.5 m to a depth of 27.5 m at a mean speed of 9m/min. during trials. Lloyd's makes exception to this requirement where water depth in the trial zone is inadequate, suitable equivalent simulating conditions will be considered as an alternative. Tests for shafting, gearing, brakes, and clutches are to be accomplished in the shop, or by type testing.

The JIS requires a no-load test, a load test, a brake test, and a performance test. The text does not specify if the required testing is to be done by the manufacturer as a shop test, or by the shipyard as onboard test.

The no-load test states that the windlass shall be run once in the normal and once in the reverse direction for a sum of 30 minutes at the rated speed.

The method of load testing is not specified, however the agreed upon method shall verify that the working load, rated speed, and overload pull are attainable. The working load is based on the type of chain selected, and the windlass should be able to continuously pull the working load for 30 minutes. The overload pull is 150% of the working load, and the windlass should be able to operate under the overload pull for 2 minutes at reduced speed. The rated hoisting speed shall be .15 m/sec (9m/min) or more.

The brake test shall confirm the holding power of the brake, either by test or calculation. The holding load is 130% of the working load. The brake shall also be tested onboard with the anchor dropping controlling the holding load by applying the brake at each half chain length.

Performance testing shall include confirmation of remote control operation, automatic control brake system, and the clutch and slipping clutch.

For winch testing, the JIS identifies type inspection for everything except no-load testing and operating inspection of the brake. The no-load operating test shall be carried out by operating at light line condition for 30 minutes, 15 in each direction. The brake test includes normal operation of the brake with the winch running at no-load.

ANCHOR WINDLASS, CARGO, AND MOORING WINCH TRIALS			
	ABS	**Lloyd s**	**JIS**
Operational or Performance Test	Brake, clutch, lowering, hoisting, proper chain path and stowing.	Shafting, gearing, and clutches to be accomplished by shop or type testing.	Remote Control, brake and clutch
No-load test	N/A	N/A	30 min @ rated speed
Brake Test	Operational only	Operational only	130% of working load
Load Test	Lifting capability - 82.5 m (45 fathoms)	Lifting capability - 82.5 m (45 fathoms)	30 minute continuous pull @ working load. 150% overload for 2 minutes
Lifting Speed Test	N/A	9 m/min	9 m/min

Table B-1 - Anchor Windlass, Cargo, and Mooring Winch Test Requirements

Automatic / Remote Controls and Monitoring Systems

Each classification society and regulatory body references testing of automatic and remote controls in their documentation except for the ASTM. Differences and similarities in the testing requirements of these agencies are outlined in Table B-2.

The ABS rules state in general that automatic or remote control and monitoring systems and associated equipment are to be tested in the presence of the Surveyor, under normal operating conditions and for the period that the surveyor may deem necessary or otherwise, specified in other sub-sections.

Additionally, for automatic and remote control of propulsion systems, the ability to effectively control the propulsion from the remote propulsion control station is to be demonstrated to the satisfaction of the Surveyor during sea trials or dockside. These trials are to include propulsion control transfer, propulsion starting, verification of propulsion control responses, propulsion control power failure, actuation of propulsion emergency stop device (if installed on navigation bridge), and for turbine driven ships actuation of the shaft turning gear. Independent manual control of the propulsion machinery is to be demonstrated during the tests or trials to the satisfaction of the surveyor. This is to include demonstration of independent manual control through the full maneuvering range and transfer from automatic control.

Tests for equipment integrity are to be carried out for remote or automatic control and monitoring equipment installed in ACC, ACCU or ABCU classed vessels. Most environmental testing is to be carried out by the equipment manufacturer in accordance with the applicable ABS Tables (4/11.1 and 4/11.2). Performance testing of such equipment can be accomplished at the manufacturer's plant or onboard after installation.

The ABS rules also requires certain remote or automatic control and monitoring systems be demonstrated to the satisfaction of the surveyor during a sea trial in addition to the trial requirements above. Most demonstrations can best be tested before sea trials using simulated failures to ensure proper corrective action. The following systems are to be tested:

- Automatic or remote control and monitoring system for propulsion machinery and electrical power generating equipment. This test is to include sequential operation of automated systems where fitted. From the centralized control and monitoring station, the transferring of the required standby vital auxiliary pumps is to be included.
- Local control of propulsion machinery
- Fire control and alarm system - In addition to alarms and detectors, where the fire main is not maintained pressurized it is to be demonstrated that one fire pump can be started from the bridge.
- Automatic starting of the machinery space bilge pumps where fitted.
- Automatic starting of the pumps serving the fuel oil settling tanks and daily service tanks is to be demonstrated where fitted.
- Operational test of propulsion machinery - After the propulsion machinery is running for at least 2 hours, the machinery is to be operated over the full range of power to demonstrate the adequacy of all control systems. The tests are to be at least 6 hours including the initial 2 hours of running time. For vessels classed ACCU, the ability to control the machinery functions correctly of all loads and engine maneuvers without any manual intervention in the propulsion machinery space is to be demonstrated for an additional period of four hours. Propulsion machinery or engine response to throttle control demands is to be tested during the trials and after final adjustments to demonstrate that no part of the plant or engine is jeopardized by the rate at which the throttle is moved from one extreme position to the other. The loss of electrical power is to be simulated with the main engine running. On restoration of power, the ship's service auxiliaries and main engines are to be started from the central control and monitoring station and are to operate satisfactorily without local adjustment. For vessels classed ABCU, the successful operation of the propulsion machinery is to be demonstrated with the propulsion machinery space unattended for 12 hours.

Lloyd's rules state that before a new installation is put into service trials are to be carried out. It will be expected that most of these trials will be carried out before the official sea trial of the ship. During sea trails, systems dynamics tests are to be carried out to demonstrate overall satisfactory performance of the control engineering installation.

In addition to the tests outlined above, the suitability of the installation to operate in the unattended mode is to be demonstrated during sea trials over a four to six hour period observing the following:

- Occurring alarms and the frequency of operation using bridge control.
- Any intervention by personnel in the operation of machinery.

The suitability of the installation for operation from the centralized control station is to demonstrated during sea trials.

DNV rules require test programs for software module testing, integration testing, system testing, and on-board testing be submitted for approval. Each test program is to include a description of each test item, and a description of the acceptance criteria for each.

DNV rules require approval tests for software modules, integration testing, and system testing to be accomplished by the manufacturer at his facility. The tests are to verify that all relevant rule requirements are met. The tests are only to cover the requirements given by the rules. The test programs are to be specific as to how the various functions are to be tested and what is to be observed during the tests. Failures are to simulated as realistically as possible, preferably by letting the monitored parameters exceed the alarm and safety limits. Alarm and safety limits are to be checked. It is to be verified that all automatic control functions are working satisfactorily during normal load changes.

On-board testing required by DNV is to include:

- During installation the correct function of individual equipment packages, together with establishment of correct parameters for alarm, control, and safety.
- During installation and sea trials the correct function and integration of systems, including the ability of control systems to keep any process equipment within the specified tolerances.
- The correct protection and capacity of power supplies.

For Periodically Unattended Machinery Spaces

Each integrated computer system is to be tested after installation onboard. The tests are primarily intended to demonstrate correct functioning and communications between computer the system and the connected equipment (sensors, mechanical interfaces). The tests are to be carried out concurrently with the tests for the class notations EO and NAUT.

Monitoring and automatic controls

Sea trials should be reserved solely for the testing of the automatic and remote control systems, and the fire alarm system. Other tests should be completed alongside the dock. The sea trials are to include a 4 hour continuous operation with unattended machinery spaces. a detail test program is to be submitted and approved prior to trials.

Failure conditions are to be simulated as realistically as possible, preferably by letting the monitored parameters exceed the alarm and safety limits. Automatic control systems are to be tested by varying the parameters having an effect on the controlled process.

Electrical Generating Systems

At bridge control at half speed ahead, simulate a fault condition causing automatic stop of electric power generator.

For plants with automatic start and connection of stand by unit, check restart of all essential auxiliaries, and that bridge control is again operative without manual intervention.

For plants with more than one generator running in parallel, check that the stopped unit is automatically disconnected from the switchboard, and that the generator capacity of the remaining units is sufficient for propulsion and steering functions after tripping of non-essential consumers.

Fire Alarm system

It is to be verified that the fire detectors are located such that air currents will make the system inoperative.

Remote Control System

Testing of the propulsion remote control system is to be done at sea. Prior to testing the equipment is to be run for at least 1 hour. All tests included in the program are to be carried out without manual assistance from the engine room, and all systems are to be in operation as normal for unattended machinery space.

The DNV rules also provides guidance with regard to the testing of remote control propulsion systems in three categories:

- Motor ships with fixed pitch propellers
- Motor ships with controllable pitch propellers
- Turbine ships

The guidance includes several maneuvers such as stop to start, and ahead to astern. The guidance also suggests engine starts with compressor stopped,

simulated failures of load reduction, simulated failures to ensure manual standby of control systems, and a test of the emergency stop system.

Additionally, the DNV rules outline guidance for testing of boiler plants; automatic control systems for main and auxiliary boilers, and monitoring systems.

46 CFR states the following requirements for design verification and testing of vital systems automation: All automatically and remotely controlled vital systems addressed by part 62 must be subjected to tests and inspections to evaluate the operation and reliability of controls, alarms, safety features, and interlocks. Test procedures must be submitted to the USCG for approval. The systems addressed by section 62 are:

- Remote propulsion control system
- Flooding safety
- Fire safety
- Oil-fired main boilers
- Internal combustion starting systems
- Fuel systems
- Monitoring systems

Tests must verify that automated and vital systems are designed, constructed, and operate in accordance with all applicable requirements. Tests must be performed immediately after the installation of the automated equipment, or before the issuance of the initial Certificate of Inspection.

For all automated vital systems on-line built-in test equipment must not lock out or override safety trip control systems. This equipment must indicate when it is activated.

The JIS address methods of testing automatic control systems for specific shipboard systems on smaller vessels, those systems are:

- Fuel oil systems
- Lube Oil Systems
- Cooling water systems
- Compressed air, bilge, fresh water, and sanitary systems.

Although not specifically stated, it can be assumed that due to the extent of the testing required, and the detail of the proposed test procedures, that these tests are designed to be accomplished onboard as a completed system test.

AUTOMATIC / REMOTE CONTROLS AND MONITORING SYSTEMS					
	ABS	**USCG - CFR**	**DNV**	**Lloyd s**	**JIS**
Propulsion Systems	Yes	Yes	Yes - Sea Trials	Yes - Sea Trials	N/A
Unattended Machinery Space	Yes	N/A	Yes	4-6 hours	N/A
Operation from CCS	Yes	N/A	Yes	Yes - Sea Trials	N/A
Sea Trials	Yes	N/A	Yes	Yes	N/A
Test Procedures	N/A	Preapproval Req'd	Preapproval Req'd	N/A	N/A
Flooding Safety		Yes		Dynamics tests	N/A
Fire Safety	Yes	Yes	Yes	Dynamics tests	N/A
Oil-fired Main boilers	N/A	Yes	Yes	Dynamics tests	N/A
Start Air systems	N/A	Yes	N/A	Dynamics tests	N/A
Fuel systems	Yes	Yes	N/A	Dynamics tests	N/A
Monitoring Systems	Yes	Yes	Yes	Dynamics tests	N/A
Electric Generating systems	Yes	N/A	Yes	Dynamics tests	N/A
Auto start of bilge pump	Yes	N/A	N/A	Dynamics tests	N/A

Table B-2 - Automatic/Remote controls and Monitoring Systems

Azimuth Thrusters and Dynamic Positioning Systems

The ABS, Lloyd's Register, and DNV have specific requirements for the testing of thrusters and dynamic positioning systems.

The ABS has published a separate document, *The ABS Guide for Thrusters and Dynamic Positioning Systems* incorporating the following testing criteria:

- Control equipment is to be tested in the presence of a surveyor, however this is generally a manufacturer's test.
- Hydraulic and pneumatic piping is to be pressure tested to 1.5 times the relief valve setting using the service fluid in hydraulic systems, and dry air in pneumatic systems as the testing media.
- Complete operational tests are to be carried out to the Surveyor's satisfaction on sea trials.
- The test schedule is to be preapproved, and is to demonstrate the level of redundancy established in the Failure Mode Effects Analysis.
- The test environment is to simulate the design operating conditions.

The Lloyd's Register section on thruster testing references other sections on testing including:

- The effectiveness of such auxiliary means of propulsion or maneuvering shall be demonstrated to the Surveyor's satisfaction and recorded on trials.
- Hydrostatic test of 1.5 times the design pressure

DNV rules require steering and reversing functions of thrusters to be tested during sea trial under the most severe permissible conditions. After sea trials the gears teeth are to be inspected as described in the reduction gear section. System stability is to be checked throughout the operating range. For controllable pitch propellers, the pitch function is to be demonstrated to the Surveyor.

Boilers - Hydrostatic Tests

Rules regarding the testing of boilers are found in the ABS Rules and 46 CFR. 46 CFR references PG-90 through PG-100 of the ASME Code except as noted in 46 CFR 52.01-135. The ASME Code does not specify any additional testing not included in 46 CFR. Differences and similarities in the testing requirements of these agencies are outlined in Table B-3.

52.01-135 requires a hydrostatic test to 1 1/2 times the maximum allowable working pressure. In preparing for a hydrostatic test the boiler will be filled with water of not less than 70°F and not more than 160°F. The safety valves shall be secured by means of gags or clamps. In addition to the hydrostatic testing, auxiliary boilers must be subjected to operating tests which must be completed after final installation. These operating tests are identified under the subdivision Automatic/Remote Controls.

The ABS requires the surveyor to witness a hydrostatic test of not less than 1 1/2 times maximum allowable working pressure.

Electrical Equipment, Electrical Propulsion, Testing and Trials

The ABS, Lloyd's, and DNV state requirements for testing of electrical equipment and electric propulsion systems. Differences and similarities in the testing requirements of these agencies are outlined in Table B-7. It should be noted that the USCG Marine Safety Manual outlines inspections of main electrical systems, however the manual does not specifically address testing.

Lloyd's Register Rules require that before any new installation is put into service trials are to be carried out to the satisfaction of the surveyor. These trials are in addition to any trials which may have been carried out at the manufacturer's shop, and shall include:

- Insulation resistance measurements of all circuits and electrical equipment using a DC current insulation tester. Readings shall be taken between all current carrying parts connected together and to ground so far as reasonably practical, and all parts of different polarity or phase. The minimum values of test voltage and insulation resistance are as shown on table B-4.

Boilers - Hydrostatic Test Requirements		
	ABS	**USCG - CFR**
Hydrostatic Test	1.5 Times MAWP	1.5 Times MAWP
Temperature	N/A	70°F - 160°F
Operating Tests	N/A	Auxiliary boilers only

Table B-3 - Boilers - Hydrostatic Test Requirements

Rated Voltage	Min. Test Voltage (V)	Min. Insulation Resistance (MΩ)
$V_r \leq 250$	2 x V_r	1
250< $V_r \leq 1000$	500	1
1000< $V_r \leq 7200$	1000	$\frac{V_r}{1000}+1$
7200< $V_r \leq 15000$	5000	$\frac{V_r}{1000}+1$

Table B-4 - Lloyd s Register Test Voltage and Resistance Values

- Tests to verify the effectiveness of ground continuity conductors, the grounding of non-current carrying exposed metal parts of electrical equipment, and bonding for the control of static electricity.
- Satisfactory performance of each generator, with respect to the rules, throughout a run at full rated load.
- Compliance with respect to temperature of joint, connections, circuit breakers, and fuses.
- Demonstrate the operation of engine governors, synchronizing devices, overspeed trips, reverse current, reverse power, and over current trips and other safety devices.
- Demonstrate regulation of every generator when full rated load is suddenly thrown off and when starting the largest motor connected to the system.
- Demonstrate satisfactory parallel operation, and KW and KVA load sharing of all generators capable of being operated in parallel at all loads up to normal working load.
- All essential and other important equipment is to be operated under service conditions, though not necessarily under full load, or simultaneously, for a sufficient time to demonstrate satisfactory operation.
- Electrical Propulsion equipment is to be tested under working conditions and operated in the presence of the surveyor to his satisfaction. The equipment is to have sufficient power for going astern to secure proper control of the ship in all normal circumstances. In passenger ships the ability of the machinery to reverse the direction of thrust of the propeller in sufficient time, under normal maneuvering conditions, and so bring the ship to rest from maximum ahead speed, is to be demonstrated at sea.
- Voltage drop is to be measured, where necessary, to verify that it is in accordance with specifications of Pt 6, Ch 2, Sec. 1.7.
- It is to be demonstrated by practical tests that the rules have been complied with in respect to fire, crew and passenger emergency and ship safety systems. Measured sound pressure levels of the general emergency alarm are to be recorded.
- Before a high voltage cable installation is put into service a voltage test is to be carried out. The test is to be carried out after the resistance test. AC voltage is to be not less than operating voltage, maintained for a minimum of 24 hours. DC voltages are to be in accordance with Part 6, Chpt 2, Sec. 20.3.3, and applied for 15 minutes. Following voltage tests, an insulation test is then to be repeated.

The ABS Rules requires a service trial for electrical installations. All auxiliary apparatus is to be tried under working conditions.

- Each generator is to be run for a time sufficient to show satisfactory operation, and parallel operation with all possible combinations is to be demonstrated.
- Each auxiliary motor necessary to the operation of the vessel is to be run for a time sufficient to show satisfactory performance at such load as can readily be obtained.
- All main switches and circuit breakers are to be operated, but not necessarily at full load.
- The operation of lighting system, heaters, etc., is to be demonstrated satisfactorily.
- The entire installation is to operate to the satisfaction of the Surveyor and the drop in voltage on any part of the installation is not to exceed 6%.
- Satisfactory operation of the interior communication system is to be demonstrated to the Surveyor during sea trials.
- Each power and light circuit is to have an insulation resistance between conductors and between conductors and earth of not less than the values depicted in Table B-5.
- A dielectric strength of insulation test will be performed between each electric circuit and other electric circuits and grounded metal parts, and for DC rotating machines, between brush rings of opposite polarity.
- The insulation of all rotating machinery is to be tested with the parts completely assembled. The dielectric strength is to be tested by applying a

Minimum Insulation resistance	
Up to 5 amps load	2 MΩ
10 amp load	1 MΩ
25 amp load	400,000 Ω
50 amp load	250,000 Ω
100 amp load	100,000 Ω
200 amp load	50,000 Ω
Over 200 amp load	25,000 Ω

Table B-5 - ABS Minimum Insulation Resistance

continuous voltage in accordance with table 4/5C.2. A standard voltage test using DC voltage equal to 1.7 times the AC voltage is also acceptable.

- After installation, high voltage cables are to be subjected to a test voltage with a DC voltage of 4 times the rated voltage, supplied for 15 minutes.
- A power frequency voltage test is to be carried out on high voltage switchgear and control gear assemblies in accordance with the values depicted on Table B-6.

Nominal Voltage (kV)	Test Voltage (kV)
2.5 - 3.6	10
3.6 - 7.2	20
7.2 -11	28

Table B-6 - High Voltage Switchgear Test Values

- Insulation tests for semiconductor converters for propulsion are to be done with all parts completely assembled not withstanding tests carried out by the manufacturer on individual parts. Testing will be accomplished by applying voltage having a crest value equal to the square root of two times the specified test voltage for 60 seconds.
- All propulsion cables, other than internal wiring are to be subjected to dielectric insulation tests.

The ABS also requires complete dock and sea trial tests to be carried out including duration runs and maneuvering tests which should include: a reversal of the ship from full speed ahead to full speed astern, tests for operation of protective devices, and stability tests for control. All tests necessary to demonstrate that each item of the plant and the system as a whole are satisfactory for duty are to be performed. Immediately prior to trials, the insulation resistance is to be measured and recorded.

The DNV Rules require testing to the surveyor’s satisfaction before any electrical installation is put into service. Testing shall include:

- All generating sets together with their switchboard equipment are to be run at full-rated load to verify that electrical characteristics, commutation, speed governing, overspeed trips, overload protection, lubrication, and vibration levels are within satisfactory limits. Voltage and speed regulation are given in sects. 3A, 5B, and Ch 2, Sec. 2 E300, Sec. 3 E300, Sec. 4 E300.
- Generators intended for parallel operation are to be tested to verify that synchronizing systems, load sharing, and reverse power protection are satisfactory. Requirements are in Sec. 5B and Ch 2, Sec. 2 E300, Sec. 3 E300, Sec. 4 E300.
- Insulation resistance of every completed generator is to be tested when clean and dry, with the generator hot. Readings will be IAW IEC Publication 92-375 (clause 13 tables II and III).
- Before main, emergency, and distribution switchboards are put into service their insulation resistance is to be not less than 1 MΩ.
- Switchgear is to be tested on load to verify suitability and operation of overcurrent release and other protective devices.
- An insulation resistance test is to be applied to all outgoing circuits, a minimum value of not less than 1 MΩ is to be attainable. This also applies to instrumentation and communication systems with voltages over 30 VAC and 50 VDC.
- All consumers for essential and important purposes are to be tested under normal operating conditions to ensure they are suitable for their purposes.
- All motors and associated control gear are to be run under normal operating conditions to demonstrate power, operating characteristics, commutation, speed, direction of rotation, and alignment.
- Insulation resistance of motors is to be in accordance with Table B-6.
- Tests may be required to verify that the allowable voltage drop as stated in Sec. 3A is not exceeded.
- Grounding connection and conductors are to be checked.
- Cables with terminations and splices are to be subjected to a voltage test after installation,

applied for 15 minutes with a DC voltage 4 times the rated phase voltage.

The DNV Rules also require an electric propulsion system to be subjected to final tests at a sea trial. The final sea trials assumes that satisfactory tests of all subsystems have been carried out according to Main Class requirements. The sea trial shall follow a detailed test program approved by DNV which includes:

- Tests of the propulsion plant in normal conditions, and in any abnormal condition in which the equipment is intended to operate.
- Start-up and stop sequences, and power management system control when relevant.
- Alarms and indicators critical to system operation.
- All control modes from all control locations.

Electrical Equipment and Electric Propulsion			
	ABS	**DNV**	**Lloyd s**
General			
Service Trial	Yes		Yes
Insulation Resistance Readings	IAW Table B-5, all system readings immediately prior to trials.	Main switchboards, and outgoing circuits >1MΩ, motors IAW Table B-4	Motors IAW Table B-4
Grounding, Bonding, and Dielectric Strength of Insulation Test	Yes, Including all propulsion cables.	Yes - Generators clean, dry, and hot.	Yes
Voltage Testing - AC cables	N/A	N/A	Yes - On high voltage cables for 24 hrs
High Voltage Switchgear and Control Gear	Voltage Testing - Per Table B-6	Load testing to verify protective devices	N/A
Voltage Testing - DC cables	Yes - 4 times rated for 15 min	Yes - 4 times rated for 15 min	Yes - for 15 min.
Auxiliary and essential equipment	Yes - under working conditions	Yes - under working conditions	Yes - under service conditions
Lighting Systems and Heaters	Yes	N/A	N/A
Interior Communications	Yes - During Sea Trials	N/A	N/A
Temperature Testing	N/A	N/A	Circuit breakers, fuses, connections
Fire, crew, and passenger emergency and ship safety systems	N/A	N/A	Yes - Sound level of general alarm.
Generator Testing			
Full Rated Load	Yes	Yes	Yes
Engine governors, synchronizing devices, overspeed trips, reverse current, reverse power, and over current trips and other safety devices.	Yes	Yes	Yes
Sudden load changes	N/A	N/A	Yes
Parallel operation, and KW and KVA load sharing.	Yes	N/A	Yes
Voltage Drop	Yes < 6%	Yes	Yes
Electric Propulsion Equipment			
Operational Test	Yes - Complete dock and sea trial, duration runs and maneuvering tests.	Yes - Sea Trial	Yes - Working Conditions
Astern Power Demo	Yes	N/A	Yes
Reverse Thrust to Bring Ship to Rest	Yes	N/A	Yes - Passenger ships only
Stability Tests for control	Yes	N/A	N/A
Start and Stop Sequences	N/A	Yes	N/A
All control Modes from all locations	N/A	Yes	N/A
Critical Alarms and Indicators	N/A	Yes	N/A

Table B-7 - Electrical Equipment and electrical Propulsion Test Requirements

Elevators

ABS rules and the ASTM Book of Standards both address elevator testing. ASTM guidelines require that new elevators, after completion and before being put into service, shall be subjected to tests onboard the vessel to determine that the installation conforms with the requirements and that the safety devices function accordingly. The following is included in the test program:

- Test of car safety with rated load in car
- Test of counterweight safety
- Test of governor tripping speed
- Test of hoistway and car door interlocks
- Operating test of entire installation including check of car and position indicators
- Test of driving machine brake with maximum load weight (rated load plus weight of car) plus 50% of rate load
- Test of buffers
- Test of slack or broken rope switch
- Test of dynamic load at 150% of rated load
- Test of static load at 200% of rated load for 10 min
- Test of emergency stopping devices and communications equipment
- Test of load weighing device

The ABS publishes a *Guide for Construction of Shipboard Elevators*, and the requirements contained within are very similar to those requirements of the ASTM documentation. The ABS guide is identical to the ASTM manual with respect to seven of the twelve test requirements, and the two documents differ in the following ways:

- The driving machine brake test is to be done with an additional 25% of rated load vice 50% as specified by ASTM
- The ABS requires a test of the manual hoisting device
- The ABS does not specify a 150% dynamic load test, nor a 200% static load test
- The ASTM manual also requires a test of the emergency stopping devices and communications equipment, and a test of the load weighing device.

Fire Detection Systems

ABS Rules and ASTM Standards reference fire detection systems. Differences and similarities in the testing requirements of these agencies are outlined in Table B-8.

The ABS Rules do not specifically identify testing requirements for these systems, however the ABS rules do state that fire detection systems shall meet the requirements in Regulation II-2/13 and 2/14 of SOLAS 1974. The applicable SOLAS Regulations state that after installation the system shall be tested under varying conditions of engine operation and ventilation.

The ASTM standard states that functional tests should be performed on all components of the system for system commissioning. The manufacturer's testing procedure should be followed, and should include at least the following:

- Smoke detectors - Each smoke detector in the system should be tested separately by introducing smoke or other appropriate test gas. Receipt of an alarm condition should be verified at the control unit.
- Heat detectors - Each detector should be tested separately by applying heat according to the manufacturer's recommended procedure. Receipt of an alarm condition should be verified at the control unit.
- Manually actuated fire alarm boxes - Each box should be operated and the receipt of an alarm condition should be verified at the control unit.
- Flame detectors - Each detector should be exposed to radiation from an open flame or appropriate test lamps and the receipt of an alarm condition should be verified at the control unit.
- Alarm signaling devices - Each device shall be operated during the testing of detectors and manually operated fire alarm boxes. The proper operation and sound levels should be verified.
- Fire and smoke doors and dampers - Operate the alarm system and verify proper operation of automatically operated doors and dampers.
- Control panel - In addition to functional tests described, continuity should be interrupted and a trouble indication observed with each interruption. Primary operating power should be interrupted, and the control unit observed for proper operation and standby power. It should be verified that appropriate indications of abnormal conditions occur during power interruptions.
- Sample extraction smoke detection systems - Sample systems should be tested by introducing smoke into each sampling point and observing

an alarm indicating with each introduction. All supervisory functions should be tested by simulating the necessary abnormal conditions and observing proper indications at the control unit. As a minimum these supervisor functions should include: Blowers, primary power, annunciator panel, internal power circuitry, photoelectric lamps, detection module

- Standby Batteries -Batteries should be subject to loading and the voltage observed on the battery after loading has been applied. Manufacturers recommendations should be followed regarding amount and duration of loading.
- Fluid control systems with internal parts that may be damaged by the test pressure maybe tested to MAWP.

The ABS rules require hydraulic and pneumatic cylinders to be hydrostatically tested to 1.5 times the MAWP for steel cylinders, and not less than twice the MAWP for cast iron and nodular iron cylinders. This test does not have to be witnessed by the Surveyor.

For steering gear hydraulic systems the ABS requires a manufacturer's hydrostatic shop test to 1.5 times the relief valve setting for steel cylinders, and not less than twice the relief valve setting for cast iron and nodular iron cylinders. After installation in the vessel the complete piping system is to be subjected to a hydrostatic test equal to 1.1 times the relief valve setting, including a check of the relief valve operation.

For controllable pitch propeller systems, after installation in the vessel the complete piping system is to be subjected to a hydrostatic test equal to 1.5 times the design pressure, including a check of the relief valve operation. All testing is to be performed in the presence of the ABS Surveyor.

The DNV rules require controllable pitch propeller systems to be function tested and pressure tested in the presence of the Surveyor. The hydraulic system is to be tested to 1.5 times the design pressure, and the propeller is to subject to 1 bar to ensure tightness. The propeller is to be tested during sea trial with full ahead running and reversing at maximum permissible RPM and at maximum astern pitch.

Fire Detection Systems - Test Requirements		
	ABS	**ASTM**
Operational Test	SOLAS - Test under varying conditions of engine operation and ventilation	N/A
Functional Tests	N/A	Smoke Detectors, heat detectors, alarm boxes, flame detectors, alarm signaling devices, fire and smoke doors and dampers, control panels, sampling systems, stand-by batteries,

Table B-8 - Fire Detection Systems - Test Requirements

Fluid Power and Control Systems

The ABS rules, DNV rules, and 46 CFR address testing of fluid power and control systems. Section 58.30-35 of 46 CFR requires the following installation tests:

- A shop test to a hydrostatic test pressure of 1.5 times the MAWP may be allowed in lieu of installation testing. The test shall last for a sufficient amount of time to check for leaks, strength, and porosity.
- After hydrostatic testing in the shop the system may be tested after installation as a complete system by installing the driving unit and blowing the relief valve. Otherwise the system must be hydrostatically tested to 1.5 times the MAWP.
- Systems containing rupture discs may be tested to MAWP in lieu of 1.5 times the MAWP provided the accumulators have been previously tested and certified.
- Fluid power and control systems shall be purged with an inert gas or the working fluid prior to shipboard testing.

Incinerators

Only the ASTM and the JIS Standards address the testing of shipboard incinerators. The ASTM

Standard requires and installation test to be conducted after installation to ensure that all of the control components have been properly installed and that all parts of the incinerator are in satisfactory operating condition. The specific tests include:

- Flame Safeguard - Verify the operation of the flame safeguard by flame and ignition failures. Operation of the audible alarm and visible indicator shall be verified. The shutdown times shall be verified.
- Limit Controls - Shutdown due to the operation of the limit controls shall be verified.
- Oil pressure limit control - Lowering the fuel oil pressure below that pressure which is safe for combustion shall initiate a safety shutdown.
- Other Interlocks as specified by the manufacturer will be tested for proper operation.
- The combustion controls shall be tested for smooth operation.
- The programming controls shall be able to program and cycle the unit in the intended manner. A stopwatch will be used to time prepurge, purge, and post-purge cycles.
- Fuel supply controls will be checked for proper operation in all modes of operation and shutdown.
- A low-voltage test shall be conducted to satisfactorily demonstrate that the fuel supply to the burners will be shut off before a malfunction results from the low voltage.
- Switches will be tested to verify operation.

The JIS rules require that the shipboard tests of the incinerator conform to operating tests and inspection , and tests of safety and alarm devices.

Inert gas systems

The ABS and Lloyd's register both reference inert gas system testing.

The ABS documentation does not specifically address testing required during construction, however the rules do describe in detail the following annual and periodic surveys regarding inert gas systems:

The inert gas system is to be generally examined in so far as can be seen and placed in satisfactory operating condition. The survey should include:

- External examination of all components
- Confirmation of proper operation of inert gas blowers.
- Observation of the operation of scrubber room ventilation system.
- Deck seals or double block and bleed assemblies, and non-return valves are to be examined externally and proven in operation. Automatic filling and draining of the deck seal is to be checked.
- Verify operation of all remotely operated or automatically controlled valves, and in particular the flue gas isolating valves.
- Verify operation of the interlocking features of the soot blowers.
- Verify the automatic operation of the gas pressure regulating valve.
- Verify the operation of the following alarms and safety devices using simulated conditions where necessary:
  - Low water pressure or low water flow rate to flue gas scrubber
  - High water level in flue gas scrubber.
  - High gas temperature at IGS blower discharge
  - Failure of inert gas blowers
  - Oxygen content above 8% by volume
  - Failure of the power supply to the automatic control system.
  - Low water level in the water seal.
  - Gas pressure less than 100 mm water.
  - High gas pressure.
  - Accuracy of fixed and portable oxygen measuring systems.
  - Insufficient fuel oil supply.
  - Failure of power supply to generator
- For systems with a separate inert gas generator system, automatic combustion control systems are to be examined and tested as necessary.
-

Lloyd's Register briefly states that "The inert gas system, including alarms and safety devices, is to be installed on board and tested under working conditions to the satisfaction of the Surveyor."

Internal combustion engines

The ABS, Lloyd's register, DNV, and the JIS all reference testing of internal combustion engines. Differences and similarities in the testing requirements of these agencies are outlined in Table B-9.

ABS Rules require a shipboard trial. Before final acceptance, the entire installation is to be operated in the presence of the surveyor to demonstrate its reliability and sufficiency to function

satisfactorily under operating conditions and its freedom from dangerous vibration at speeds within the operating range.

Additionally, there is an ABS requirement for a shop trial to be completed at the manufacturers facility. ABS Rules also require hydrostatic testing of engine components (listed in table 4/4.2), however, this testing is to be accomplished by the engine manufacturer. There is an additional requirement for engines with a bore over 300 mm to test pumps associated with the engine and reduction gear, this is also a manufacturer requirement.

Lloyd's Register requires hydraulic tests of engine components (listed in Table 2.9.1), it appears that this testing would be accomplished by the manufacturer. Lloyd's also requires type testing to be accomplished by the manufacturer.

DNV rules require similar manufacturer's hydraulic, material and type testing. Specifications are given for necessary measurements and parameters. Type testing of engines is divided into three parts: internal, type, and component testing. Engines not built to a specific type are required to undergo workshop testing.

The JIS suggest a method for calculating main diesel engine output at sea trials. To ensure accuracy of these calculations the following precautions are to be observed:

- Adjusted condition of components at sea trial should be as close to shop conditions as possible.
- In order to minimize measurement errors, the main engine should be in a settled load condition with the least fluctuation.
    - Sea state should be as good as possible
    - Ship shall be run as straight as possible with no rudder movement
    - After increasing load or changing course, sufficient time will be allowed to settle the load.
- Measurements of various items shall be taken simultaneously when possible.
- Measured values shall be averaged except those of large deviations.

46 CFR subpart 58.10 deals with internal combustion engine installation, however there is no specific reference to testing.

Internal combustion Engines				
	ABS	**DNV**	**Lloyd s**	**JIS**
Shipboard Trial	Yes - To satisfaction of Surveyor including freedom from vibration	N/A	N/A	Yes - See precautions above.
Hydrostatic test of components	Manufacturer requirement	Manufacturer requirement	Manufacturer requirement	N/A

Table B-9 - Internal Combustion Engines - Test Requirements

Lifesaving Appliances

The DNV rules and 46 CFR both address testing of lifesaving appliances. The SOLAS convention addresses manufacturer's testing, and production testing, and references Resolution A.521(13) regarding testing of life-saving appliances.

46 CFR requires an initial inspection of lifesaving appliances and arrangements for certification and includes a demonstration of the following:

- The proper condition and operation of the survival craft and rescue boat launching appliances at loads ranging from light to 10% overload.
- The proper condition and operation of lifeboats and rescue boats including engines and release mechanisms.
- The proper condition of floatation equipment such lifebuoys, lifejackets, immersion suits, work vests, lifefloats, buoyant apparatus, and associated equipment.
- The proper condition of distress signaling equipment, including emergency position indicating radio beacons, search and rescue transponders, and pyrotechnic signaling devices.
- The proper condition of line throwing appliances.
- The proper condition and operation of embarkation appliances, including embarkation ladders and marine evacuation systems.

- The ability of the crew to effectively carry out abandon ship and fire fighting procedures.
- The ability to meet the egress and survival craft launching requirements of this part.
-

The DNV rules follow closely to the recommendations of the International Maritime Organization (SOLAS A.521(13)). Lifesaving devices and arrangements are to be tested to the recommendations of the *Recommendation on Testing Life-Saving Appliances* . The Assembly resolution A.521(13) has been superseded by Assembly resolution A.689(17) which is currently on order.

Machinery

The broad topic of machinery testing is referenced by the ABS rules and the CFR.

The ABS rules state that a final under-way trial is to be made of all machinery, including the steering gear and anchor windlass. All automatic controls, including trips which may affect the vessels propulsion system, are to be tested underway or alongside the pier to the satisfaction of the surveyor.

46 CFR references the rules of the ABS or other classification society as applicable standards for testing of main and auxiliary machinery except as outlined in 46 CFR subchapter 58. Like the ABS rules, the CFR states that: The operation of main and auxiliary engines, boilers, steering gear, and auxiliaries shall be observed on the trial trip of each new vessel. All deficiencies which affect the safety of the vessel shall be corrected to the satisfaction of the OCMI.

Noise Levels

Testing for allowable noise levels is addressed by the DNV rules, JIS, 46 CFR, ABS Guidance notes, and Enclosure 3 to NVIC 12-82. Table B-11 outlines differences and similarities between the CSARB standards.

46 CFR does not specifically address noise testing, but does cite *IMO Assembly Resolution A.468 (XII), Code On Noise Levels On Board Ships, 1981* as the governing document for allowable noise. Machinery space noise levels as shown on Table B-10 shall not be exceeded.

The NVIC 12-82 documentation addresses noise testing equipment, measurement, and survey. Sound level meters are to meet ANSI type II requirements (S1.4-1971 (R1976)).

With respect to measurement, the NVIC cites the applicable procedures of *ANSI S1.13-1971 (R1976), Methods for Measurement of Sound Pressure Levels, and ANSI S1.2-1962 (R1976), Method for the Physical Measurement of Sound.* The NVIC also suggests the use of *ISO Standard 2923-1975 (E), Acoustics-Measurement for Noise Onboard Vessels*. Specifically, noise measurements should be taken in decibels using an A weighted filter. The meter should be set to slow response and the measuring time should b eat least 5 seconds. Intermittent and transient noise sources should be measured using meters with “peak-hold” or “maximum-hold” capabilities.

IMO Allowable Noise Levels	
Machinery control room	75 dB(A)
Manned machinery space	90 dB(A)
Unmanned machinery space	100 dB(A)
Periodically unattended machinery space	110 dB(A)
Workshop	85 dB(A)
Any other workspace around machinery	90 dB(A)

Table B-10 - IMO allowable Noise Levels

In regard to survey, all operating conditions underway and in port should be considered, however, for standardization noise surveys should be conducted under the following conditions:

- Measurements underway should be taken with the ship in a loaded or ballasted condition, operating at normal design service speed with all normal auxiliaries in operation.
- Noise level measurements in spaces containing emergency equipment should be taken with the equipment operating. Adjoining space need not be measured with such equipment running.
- Measurements in port should be taken with cargo handling equipment operating.
- Measurements should be taken at the principal working and control stations of crew members in the machinery spaces and adjacent control rooms. Special attention shall be paid to areas where voice communication is important such as phone booths. Measurements should be taken at all workshops and points normally visited during routine inspection.
- Noise levels should be measured in all areas where work is carried out, and in all spaces

where crew members may be exposed to high noise levels even for a short time.

- Noise levels need not be measured for normally unoccupied spaces, holds, deck areas and other spaces which are remote from noise and where a preliminary survey shows noise levels below 70 dB (A).

A new set of ABS guidelines published in December of 1997 entitled "Guidance Notes on the Application of Ergonomics to Marine Systems" references noise testing. Like 46 CFR, the ABS also cites *IMO Assembly Resolution A.468 (XII), Code On Noise Levels On Board Ships, 1981* as the applicable document for vessel design. The prescribed allowable noise levels in machinery spaces are the same as those stated by 46 CFR . Additionally, there are permissible noise levels given for navigation spaces, accommodation spaces, and service areas. These levels have been adopted from *IMO Assembly Resolution A.468 (XII), Code On Noise Levels On Board Ships, 1981*. Other than these references, the ABS guidelines do not specifically address noise testing.

The DNV rules cite *ISO 2923* except where the rules deviate. A test program including specifications for measuring locations, required loading conditions, required operating conditions for machinery, and instrumentation to be used is to be approved.

The measuring positions are to be selected as to give a representative description of the noise situation onboard the ship. A higher density of readings is required closer to major noise sources. The number and location of measuring positions is to be approved by the society prior to noise testing. The rules also further define the requirements for noise survey in accommodation and public spaces. The distribution method for sleeping cabins involves dividing the length of the ship into three sections and measuring 40% of the cabins in the aft end, 25% in the midship section, and 15% in the forward section.

The JIS specifies testing requirements for noise levels in accommodation areas and machinery spaces.

For accommodation areas:

<u>Conditions</u> - For noise level measurements in accommodation areas the ship must be ballasted or fully loaded, going straight ahead at sea. The main engine shall be run at normal output, and auxiliary machinery necessary for normal voyage conditions shall be in operation. Intermittently operating equipment shall be in the stopped condition. Doors and windows to subject spaces will be closed. Ventilation will be in the normal condition an the room will be unoccupied.

<u>Measurement Procedures</u> - Instruments shall be as specified in JIS C 1502 or equivalent. Meters shall be set on slow response, and measurements shall be for 5 seconds.

<u>Locations</u> - Locations are divided into three categories: locations in which measurements are mandatory, locations which are measured as required, and locations which are analyzed for frequency.

For machinery areas:

<u>Conditions and Measurement Procedures</u> are the same as above.

Locations for measurements are specifically identified on Table 2 of the JIS 0904-81.

<u>Piping Systems - Pressure Testing</u>

Noise Levels					
	ABS	**USCG - CFR**	**DNV**	**NVIC 12-82**	**JIS**
Noise Levels	IMO A.468(XII) See Table B-10	IMO A.468(XII) See Table B-10	ISO 2923	ISO 2923	N/A
Sound Level Meters	N/A	N/A	N/A	ANSI Type II	JIS C 1502
Specific Test Conditions	N/A	N/A	N/A	Yes - see above	Yes
Test Program Approval	N/A	N/A	Yes	N/A	N/A
Measurement Procedures	N/A	N/A	N/A	ANSI S1.13-1971 ANSI S1.2-1962	Yes
Specified Measuring Locations	N/A	N/A	Yes	N/A	Yes

Table B-11 - Noise Level Test Requirements

Requirements for pressure testing of piping are referenced in 46 CFR, Lloyd's Rules, DNV, and the ABS Rules. Differences and similarities between the CSARB rules and regulations are outlined in Table B-13.

Section 56.97-1 of 46 CFR outlines the general requirements of piping pressure testing. The requirements apply to pressure tests of piping in lieu of 137 of ANSI-B31.1.

- Leak tightness - The requirement for leak testing must be met by a hydrostatic leak test prior to initial operations. Where a hydrostatic test is not practicable, a pneumatic test (56.97-35) or initial service leak test (56.97-38) may be substituted if approved.

1. The piping system should at no time be subjected to a stress greater than 90% of it's yield strength.
2. Pneumatic tests can be used in lieu of hydrostatic tests only when:
   a) Piping assemblies cannot be safely filled with water, or
   b) Piping subassemblies cannot tolerate traces of the testing medium, or
   c) The piping subassemblies have been previously hydrostatically tested to the pressure required by 56.97-30(e).
3. A pneumatic test of not more than 25 psi can be used to locate large leaks prior to a hydrostatic or pneumatic test.
4. A hydrostatic test of the piping may be used in lieu of testing required by subassemblies.

Section 56.97-5 of 46 CFR requires testing of non-standard fittings to twice the pressure stamped thereon, not to exceed 90% of yield strength. Non-standard fittings include: welded valves and fittings, manifolds, and seacocks. Fittings listed in Table 56.60-1(b) need only be tested to the applicable standard.

Section 56.97-25 of 46 CFR outlines procedures to prepare for testing, such as:

- Exposure of joints
- Addition of temporary supports to hold weight of test liquid.
- Restraint or isolation of expansion joints.
- Isolation of equipment not subjected to pressure test.
- Treatment of flanged joints containing blanks.
- Precautions against Precautions against test medium expansion.

Section 56.97-30 of 46 CFR outlines requirements for hydrostatic testing:

- Provision of air vents at high points.
- Test medium and test temperature
- Check of test equipment before applying pressure
- Examination for leakage after applying pressure.
- Minimum required hydrostatic test pressure will be 1.5 times MAWP except as noted in 56.97-30(f) and 56.97-40.
- Maximum permissible hydrostatic test pressure:
  - Not to exceed maximum test pressure of any fittings.
  - Not to exceed 90% of yield strength.
- Hydrostatic test pressure must be maintained for a minimum of ten minutes, or as necessary to check for leakage.

Section 56.97-35 of 46 CFR outlines requirements for pneumatic tests:

- Test medium and test temperature.
- Check of test equipment before applying pressure.
- Procedure for applying pressure.
- Examination for leakage after applying pressure.
- Minimum required pneumatic test pressure will be not less than 1.2 nor more than 1.25 times MAWP except as provided by 56.97-35(g) or 56.97-40.
- Maximum permissible pneumatic test pressure may not exceed the maximum test pressure of any component.
- Pneumatic test pressure shall be maintained for a minimum of ten minutes, or as necessary to check for leakage.

Section 56.97-38 of 46 CFR outlines requirements for initial service leak testing:

- Initial service leak tests are acceptable when other types of tests are not practical or when leak tightness is conveniently demonstrable due to the nature of the service.
- Piping must be brought up to MAWP slowly to prove the system is leak-tight.

Section 56.97-40 of 46 CFR outlines requirements for installation tests of piping systems.

- The following piping systems shall be tested to 1.5 times the maximum allowable working pressure of the system:
  - Class I steam, feed, and blowoff piping, including attachment to boilers with no practical means of blanking off.
  - Fuel oil discharge piping between the pumps and burners, but not less than 500 psi.
  - High pressure piping for tank cleaning operations.
  - Flammable or corrosive liquids, and compressed gas cargo piping, but not less than 150 psi.
  - Any Class I, I-L, or II-L piping.
  - Cargo Oil piping.
  - Firemains, but not less than 150 psi.
  - Fuel oil transfer and filling piping.
  - Class I compressed air piping.
- Refrigeration **-** Test to design pressure either hydrostatically or pneumatically.
- Fluid power **-** Hydrostatic test to 1.5 times the maximum allowable working pressure of the system, except where internal components would be damaged, then test to MAWP.
- Liquefied petroleum gas cooking and heating systems **-** Pressure test distribution tubing to 5 psi.
- Class II piping systems shall be tested under working conditions by means of an initial service leak test. Piping must be brought up to MAWP slowly to prove the system is leak-tight.

The ABS Rules require the following pressure tests:

- Steam, boiler feed, and blow-off piping is to be tested, preferably before installation, to 1.5 times the design pressure (MAWP). Pipes attached to the boiler which cannot be isolated are to be tested to the same hydrostatic pressure to which the boiler is tested.
- Fuel oil service system pressure lines are to be tested after installation to 1.5 times the design pressure of the system, but not less than 3.4 bar (50 psi).
- Fuel oil suction and transfer lines are to be tested after installation to 3.4 bar (50 psi).
- Starting air piping is to be tested, preferably before installation to 1.5 times the design pressure.
- Cargo oil piping systems are to be tested to 1.5 times the design pressure of the system.
- Hydraulic power piping is to be tested to 1.5 times the design pressure after fabrication.
- For steering gear piping, after installation in the vessel, the complete piping system, including power units, hydraulic cylinders, and piping is to be subjected to a hydrostatic equal to 1.1 times the relief valve setting.
- For controllable pitch propeller system piping, after installation in the vessel, the complete piping system is to be subjected to hydrostatic test equal to 1.5 times the design pressure, including a check of the relief valve operation.
- All Piping is to be tested under working conditions after installation.
- All Valves are to be subjected to manufacturer's testing.

Lloyd's Register sub-divides hydraulic testing on piping systems into two separate areas: Testing before installation on board, and testing after installation on board.

<u>Testing before installation on board</u>**:**

- All Class I and Class II pipes and associated fittings are to be hydrostatically tested to the Surveyor's satisfaction.

- All steam, feed, compressed air, and fuel oil pipes are to be similarly tested where the design pressure is greater than 3.5 bar. Testing is to be carried out before installation on board, and where applicable, before insulating and coating.
- For temperatures below 300°C, the test pressure is to be 1.5 times the design pressure.
- For temperatures above 300°C, the test pressure is material dependent as dictated by paragraph 7.1.3.
- Valve bodies are to be tested to 1.5 times the nominal pressure rating, but the test pressure need not be more than 70 bar above the design pressure.

subjected to a hydrostatic test in the presence of the surveyor at 1.5 times the design pressure. Modified for steel pipe based on permissible stress at design temp.

Hydrostatic testing after assembly on board - The piping is to be hydrostatically tested in the presence of the surveyor after installation on board, according to Table B-12.

If pipes are being welded together during assembly on board, they are to be hydraulically tested as specified above after welding. If a 100% radiographic examination and heat treatment after welding is carried out, the surveyor may refrain from

Piping system	Test pressure
Fuel oil piping	1,5 x maximum working pressure, minimum 4 bar
Heating coils in tanks	-- " --
Bilge and fire pipes	-- " --
Steam pipes, compressed air pipes and feed pipes of class III	-- " --
Hydraulic piping	1,5 x maximum working pressure. The test pressure need not exceed the working pressure by more than 70 bar
Piping systems made from non metallic material (plastic)	1,5 x maximum working pressure. Minimum 6 bar. Minimum duration 1 hour.

Table B-12 - DNV Onboard Piping System Test Requirements

the hydraulic test.

Separate pipe lengths, which have been hydraulically tested in the workshop, may be insulated before the hydrostatic test is carried out, except for connections between the pipe lengths.

Functional Testing - All piping systems are to be properly flushed, checked for leakage and functionally tested under working conditions to the satisfaction of the surveyor.

Testing after installation on board:

- Heating coils in tanks and fuel oil piping are to be tested by hydraulic pressure, after installation on board, to 1.5 times the design pressure, but not less than 3.5 bar.
- Where pipes are butt welded together during assembly on board, they are to be tested by hydraulic pressure similar to the testing required for pre-installation testing. Joints may not be insulated.
- On board hydraulic testing of butt welded joints may be omitted provided non-destructive tests by ultrasonic or radiographic methods are carried out.
- Bilge pipes accepted in way of double bottom tanks or deep tanks are to be hydrostatically tested to the same pressure as the tanks through which they pass.

DNV requires that all Class I and II pipes and integral fittings, after completion of manufacture but before insulation and coating, if any, are to be

Pressure Vessels

The ABS rules, Lloyd's Register, and 46 CFR all reference guidelines for testing of pressure vessels. Differences and similarities in the testing requirements of these agencies are outlined in Table B-14.

The ABS rules require:

- The Surveyor to witness hydrostatic tests on all boilers and pressure vessels.
- The test pressure applied is in no case to be less than 1.5 times the MAWP for vessels of materials other than cast iron or nodular iron,

and not less than twice the MAWP for cast iron and nodular iron.

- In no case is the pressure to be below 1 bar.
- Condenser bodies, with tubes and ferrules fitted, are to be tested to 1 bar.
- During hydrostatic testing, pressure vessel type cargo tanks are to be supported in the manner they are supported in the vessel.

Lloyd's Register requires boilers and pressure vessels, together with their components to withstand the following hydraulic tests:

- Boilers may be tested upon completion to a pressure of 1.5 times the design pressure, or
- Individual components can be tested to 1.5 times design pressure, and the completed boiler assembly shall be tested to 1.25 times design pressure.
- All boiler mountings are to be tested to twice the approved design pressure, except for feed check valves and other main feed system components which are to be tested to 2.5 the approved boiler design, or twice the normal pressure developed in the feed line in service, whichever is greater.

46 CFR, Section 54.10-10 outlines the requirements for pressure vessel hydrostatic testing:

- The test pressure shall be at least 1.5 times the MAWP stamped on the pressure vessel, multiplied by the ratio of the stress value "S" at the test temperature to the stress value "S" at the design temperature for the associated material. No ratio less than 1 shall be used. Stress shall not exceed 90% of yield..
- Hydrostatic test pressure shall be applied for a sufficient length of time to allow through examination of all joints and connections. Vessel and liquid shall be at the same temperature.
- Defects detected during the hydrostatic test will be removed, inspected, and repaired, after repairs the vessel can be re-tested.

Piping Systems - Pressure Testing				
	ABS	**46 CFR**	**Lloyd s**	**DNV**
Leak Tightness Testing	All piping testing under working conditions after installation	Hydrostatic, pneumatic, or initial service leak test (see restrictions above)	N/A	All piping testing under working conditions after installation
Non-standard fittings	N/A	Twice stamped pressure	N/A	N/A
Valve Bodies	Manufacturer's	N/A	1.5 times rating not to exceed 70 bar	1.5 times (manufacturer's)
Preparation for testing	N/A	Yes - see above	Before insulation and coating	Before insulation and coating
Hydrostatic Test Methods	N/A	Yes - see above	Yes - see above	N/A
Hydrostatic Test Pressure	1.5 times MAWP	1.5 times MAWP	1.5 times design.	1.5 times design.
Pneumatic Test Methods	N/A	Yes - see above	N/A	N/A
Pneumatic Test Pressure	N/A	1.2 - 1.25 MAWP	N/A	N/A
Installation Tests				
Joints Butt Welded Onboard	N/A	N/A	Hydraulic testing same as pre-installation tests, or ultrasonic or radiographic.	Hydraulic testing same as pre-installation tests, or ultrasonic or radiographic.
Class I steam, feed, and blowoff piping	1.5 times MAWP, (preferably before installation)	1.5 times MAWP	Pre-installation 1.5 times design.	Pre-installation 1.5 times design
Fuel oil discharge	1.5 times MAWP, but not less than 50 psi	1.5 times MAWP, but not less than 500 psi.	Pre-installation 1.5 times design.	1.5 times design press., post-installation,
High pressure piping for tank cleaning	N/A	1.5 times MAWP	N/A	N/A
Bilge piping in tanks	N/A	N/A	Tested to same pressure as associated tanks.	1.5 times design press., post-installation,
Flammable or corrosive liquids, and compressed gas cargo piping	N/A	1.5 times MAWP, but not less than 150 psi.	N/A	N/A
Any Class I, I-L, or II-L	N/A	1.5 times MAWP	Pre-installation 1.5 times design.	Pre-installation 1.5 times design
Cargo Oil	1.5 times MAWP	1.5 times MAWP	N/A	N/A
Tank heating coils	N/A	N/A	1.5 times design press., post-installation, not < 3.5 bar	1.5 times design press., post-installation,
Firemains	N/A	1.5 times MAWP, but not less than 150 psi.	N/A	1.5 times design press., post-installation,
Fuel oil transfer and filling piping.	After installation 50 psi	1.5 times MAWP	Pre-installation 1.5 times design.	1.5 times design press., post-installation, Min. 4 bar
Class I compressed air	1.5 times MAWP (preferably before installation)	1.5 times MAWP	Pre-installation 1.5 times design..	Pre-installation 1.5 times design
Refrigeration	N/A	Test to design pressure either hydrostatically or pneumatically.	N/A	N/A
Fluid power	1.5 times MAWP, after fabrication	1.5 times MAWP except where internal components would be damaged, then test to MAWP.	1.5 times design press	1.5 times design press., post-installation, not to exceed working pressure by more than 70 bar.
Steering Gear	1.1 times the relief valve setting	N/A	N/A	See Fluid Power
Controllable Pitch Propeller	1.5 times design pressure	N/A	N/A	See Fluid Power
Liquefied petroleum gas	N/A	Pressure test distribution tubing to 5 psi.	N/A	N/A
Plastic piping	N/A	N/A	N/A	1.5 times design press., post-installation, min. 6 bar for 1 hr
Class II piping	N/A	Test to working conditions by means of an initial service leak test	Pre-installation 1.5 times design.	Pre-installation 1.5 times design

Table B-13 - Piping Systems Test Requirements

Pressure Vessel Test Requirements			
	ABS	**CFR**	**Lloyd s**
Boilers and Pressure Vessels	1.5 times MAWP, 2 times MAWP for cast iron, always >1 Bar.	1.5 times MAWP	1.5 times MAWP
Individual Components	N/A	N/A	1.5 times MAWP
Main Feed System components	N/A	N/A	2.5 times MAWP, or 2 times normal service.
Other Boiler Mountings	N/A	N/A	2 times MAWP
Complete Boiler Assembly	N/A	N/A	1.25 times MAWP if components tested to 1.5 times MAWP
Condenser Bodies	Tested to 1 Bar	N/A	N/A
Time and Temp Req'ts	N/A	Yes - see above	N/A
Pneumatic Testing	N/A	1.25 times MAWP - Only for vessels which cannot be filled with water.	N/A

Table B-14 - Pressure Vessel Test Requirements

46 CFR, Section 54.10-15 outlines the requirements for pressure vessel pneumatic testing:

- Pneumatic testing of pressure vessels shall be permitted only for units so designed and/or supported such that they cannot safely be filled with water, or for those units which cannot be dried and where traces of test liquid cannot be tolerated.
- The pneumatic test pressure shall be at least 1.25 times the MAWP, and will use the same "S" ratio described above.
- The pneumatic test will be as follows:
  1. The pressure will be gradually increased to not more than one half the test pressure.
  2. The pressure will then be increased at 1/10 test pressure increments until test pressure is reached.
  3. The test pressure will then be lowered to MAWP for examination.
- Pressure vessels pneumatically tested shall also be leak tested.

Reduction Gears

ABS and DNV rules address reduction gear testing with respect to tooth contact. The ABS rules require a post trial examination to ensure uniform contact across 90% of the gear face width.

The DNV rules require tooth contact patterns to be verified by the Surveyor using a thin lacquer coating. The contact patterns are to be verified after part and full loading. Strain gage measurements may be required. After the sea trial the gears are to be inspected by the Surveyor for scuffs or wear marks. Oil temperature and casing temperature in way of bearings is to be checked during the full load test.

Redundant propulsion

The ABS and DNV rules specify testing requirements for redundant propulsion systems.

In a supplement dated 6/97 the ABS rules state that the following propulsion and steering testing will be accomplished during sea trials:

- Fault simulation test - simulation tests for the redundancy arrangements are to be carried out to verify that upon any single failure the propulsion and steering systems remain operational, or the back up systems may be brought quickly be brought into service.

- Communication system test - The effectiveness of the communication systems is to be tested to verify that local control of propulsion systems may be carried out satisfactorily.

The DNV rules state that the propulsion system must be subjected to final tests at sea trials in compliance with the requirements for main class.

- Additional tests are to be carried out to verify the ability of the system to maintain at least 50% of propulsion power after any single failure within the propulsion system.
- Additional tests are to be carried out to verify the redundancy of the propulsion system. The extent of testing will be based on the failure mode and effect analysis.
- It is not required that the 72-hour period of ensured operation is demonstrated. However, time-critical resources are to be sustained by adequate tests of rate of consumption and depletion.

Refrigeration Machinery

The ABS, USCG, Lloyd's, and the DNV all have specific requirements for the testing of refrigeration machinery and refrigerated cargo spaces. Differences and similarities in the CSARB requirements are outlined in Table B-15.

ABS requires the primary refrigerant system to be leak-tested with either refrigerant in the system, oil-pumped dry nitrogen or bone-dry carbon dioxide with a detectable amount of refrigerant added. The leak test shall be performed at the working pressure and no higher than the designated system pressure with safety devices (except rupture discs) installed unless susceptible to damage. Brine piping shall be tested to no less than twice the working pressure or 125 psi (8.6 bar, 8.8 kgf/cm^2), whichever is greater. The cooling test requires the insulated spaces to be cooled down simultaneously to the following design temperatures; 0 F or –18 C for quick frozen products, 10 F or –12 C for frozen products, 20 F or –6.7 C for chilled products, or temperatures approved for special types of cargo. Once the temperatures have been reached the machinery will be stopped for six hours and the internal temperature rise and external temperature will be logged every two hours.

The USCG also requires the refrigeration system to be leak tested either hydrostatically or pneumatically to their design pressures using the same gas specified by ABS. Carbon dioxide should not be used to leak test an ammonia system and no air, oxygen or flammable gas shall be used. The brine piping test or cooling test is not specified.

The acceptance tests specified by Lloyd's include the verification of control, alarm, safety and refrigerant detection systems. A test simulating failure of selected components such as compressors, fans and pumps, to verify correct functioning of alarm and systems in service. Verification of accuracy, calibration and functioning of temperature control, monitoring and recording instrumentation. Verification of air cooler fan outputs running at maximum speed, and air circulation rates and distribution arrangements in individual refrigerated spaces of chambers (the latter being done firstly with all coolers in operation and secondly with any one cooler or fan out of service). Verification of air refreshing and heating arrangements. Verification of personnel safety devices and warning systems in refrigerated spaces. Refrigeration and thermal balance tests to demonstrate the capability of the

Refrigeration Machinery Testing			
	ABS	**46 CFR**	**Lloyd s**
Leak testing	Hydro or pneumatic to working pressure.	Hydro or pneumatic to working press.	
Brine Piping	2 time working press. or 125 psi (8.6 bar)	N/A	N/A
Cooling test	0°F (-18°C) for quick frozen 10°F (-12°C) for frozen 20°F (-6.7°C) for chilled	N/A	Capacity verification test
Insulation test	6 hrs w/out machinery	N/A	Yes
Control, Alarm & Safety tests	N/A	N/A	Yes - Simulation test

Table B-15 - Refrigeration System Testing Requirements

combined refrigerating plant and insulation envelope to maintain the lowest notation temperature to be assigned. Refrigeration tests for refrigerated container ships carrying ‘porthole’ type insulated containers. If the prescribed thermal balance tests cannot be carried out due to the number of insulated containers available in the shipyard being inadequate, then either a compressor capacity test, a duct heat leakage test on as least 20% of the insulated ducting selected at random or a cell heat leakage test will be accepted. Specific logs are to be maintained on the first sea trial if fruit or fish is the cargo.

DNV specifies a dedicates a section to the testing of ships for the carriage of refrigerated cargoes, however this testing is not directly related to the shipboard operational testing described by the other classification societies, and has been discounted.

Shafting - Alignment and Torsional Vibration

Both the DNV and ABS rules address shafting alignment and torsional vibrations. The ABS documentation requires that any alignment calculations and barred speed ranges within the operating range be verified and recorded by appropriate measurement procedures in the presence of the Surveyor.

DNV rules also require the verification of alignment calculations in the presence of the Surveyor. Alignment is to be checked in afloat conditions, and may require certain loading conditions. The system stability is to be checked throughout the normal operating range including misfiring of one cylinder per engine, and impacts due to engaging clutches etc.. The stability can be checked by observing the fuel rack oscillations.

Stability Test / Inclining Experiment

Section F 1321-92 of ASTM Volume 01.07 gives a detailed procedure for stability and inclining testing. The ASTM section appears to be complete, and it is not within the scope of this project to review this complete procedure.

Steering Gear and Rudders

The ABS, Lloyd’s register, DNV, JIS and the Marine Safety Manual all reference steering gear and rudder testing.

The ABS rules state that the steering gear is to be tried out on the trial trip in order to demonstrate to the Surveyor’s satisfaction that the requirements of the rules have been met. The trial is to include operation of the following:

1. The steering gear (main and aux. - with rudder fully submerged):
    - full speed
    - half speed trial
    - passenger vessels
    - tankers, chemical carriers, or gas carriers
2. The power units, including transfer of power between units
3. The emergency power supply
4. The steering gear controls, including transfer of control, and local control
5. Communications systems
6. Alarms and indicators (can be done dockside)
7. Hydraulic pressure storage and recharging systems (can be done dockside)
8. Isolation of one power actuating system, and checking the time to regain steering capability (can be done dockside)
9. Where steering gear is designed to avoid locking, this feature shall be demonstrated.

The requirements for steering gear trials stated by Lloyd’s are similar to the requirements of the ABS as stated above. The Lloyd’s rules refers to the performance requirements of section 2.1.2 of Part 5, Chapter 19. Additionally, Lloyd’s rules requires the following testing:

After installation on board the vessel, the steering gear is to be subjected to the required hydrostatic and running tests. These test will be in accordance with the rules relating to the testing of Class 1 pressure vessels, piping, and fittings.

The DNV Rules require similar testing for steering gear as outlined by Lloyd’s, including the steering trials.

The JIS states requirements for steering gear trials that are similar to those of other classification societies. The trial is to include the tests outlined above, and additionally tests are required for safety devices and rudder lock devices. The JIS also specifies measuring items and acceptance criteria.

The Marine Safety Manual does not outline specific test requirements, but instead identifies parameters for inspection. This includes:

- System operation
- Alternate systems, alarms and indicators under simulated casualty conditions.
- Full range of rudder travel from all control stations
- Alignment of rudder angle indicators.
- Communications
- Regulatory compliance

Tank Testing

Tank testing, and tank testing for structural adequacy is referenced in the ABS rules, 46 CFR, and the DNV rules. Differences and similarities in the testing requirements of these agencies are outlined in Table B-17.

ABS rules for Testing And Trials During Construction require the following:

- After all hatches and watertight doors are installed, penetrations are fitted, and before cement or ceiling work is applied over joints, all tanks and watertight bulkheads or flats are to be tested and proven tight. Tanks are to be tested using one of three methods, hydrostatic testing, air testing, or hose testing, as directed by Table B-16.
- Hydrostatic testing - Unless air testing has been approved as an alternative, tanks are to be tested with a head of water to the overflow or to the highest point to which the contents may rise in service conditions, which ever is higher. This test may be done before or after the vessel is launched.
- Special coatings may be applied to joints provided the welds have been visually inspected by the Surveyor before the coating is applied.
- Air testing - Where permitted by Table 16, air testing or combined air and hydrostatic testing may be accepted. Air pressure differential shall be .137 bar (2 psi). All joints and boundaries are to be tested with a proper leak detection solution. Means are to be provided to prevent overpressuring of the tank during testing. Air drop testing is not an acceptable substitute for required hydrostatic or air/soap testing.
- Hose testing - Hose testing is to be carried out under simultaneous inspection of both sides of the joint. The pressure in the hose is not to be less than 2.06 bar (30 psi).

Item	Test Method
Double Bottom Tanks	Hydro, Air, or Combination Test
Deep tanks	Hydro, Air, or Combination Test
Forepeak and Afterpeak	Hydro, Air, or Combination Test
Ballast Tanks, Dry Cargo Vessels	Hydro, Air, or Combination Test
Forepeak dry space	Hose Test
Duct Keels	Hydro, Air, or Combination Test
Shaft Tunnels	Hose Test
Chain Lockers (aft of forepeak bulkhead)	To be filled with water
Hawse Pipes	Hose Test
Weathertight Hatchcovers & Closing Appliances	Hose Test
Oil Cargo Tanks, Tanker or Combination Carrier	Hydro, Air, or Combination Test
Ballast Tanks within Cargo Tank Section	Hydro Test
Ballast Tanks outside Cargo Tank Section	Hydro, Air, or Combination Test
Chemical Cargo Tanks	Hydro Test
Bulkheads at ends of Cargo Tank Sections	Hydro Test
Boundaries of Tanker Segregated Cargoes	Hydro Test
Void Space Boundaries Required to be Watertight	Hose or Air Test
Double Plate Rudders	Hydro, Air, or Combination Test
Gas Carriers:	
Pressurized gas tanks (types B & C)	Hydro Test @ 1.5 MARVS (max allowable relief valve setting)
Integral or Independent Tanks (types A & B)	Hydro or Hydropneumatic test to simulate design stress.
Membrane Tanks	Testing Subject to Special Approval
Ballast or Fuel Oil Tanks Adjacent to or Between Cargo Tank Hold Spaces	Hydro Test
Initial Service Tests, All Gas Carriers	Section 5/4A.1S.2

Table B-16 - ABS Tank, Bulkhead, and Rudder Tightness Test Requirements

Tank testing for structural adequacy - To demonstrate structural adequacy, representative hydrostatic testing of the tanks may be required in connection with the approval of design. In general this would include one tank of each type of new or unusual vessel or tank design.

Section 58.50-5 & 58.50-10 of 46 CFR require independent gas and diesel fuel tanks to be tested as follows:

- Prior to installation, tanks vented to the atmosphere shall be tested to, and must withstand, a pressure of 5 psi, or 1.5 times the max. head to which they may be subjected in service, whichever is greater. A standpipe 11.5 feet high may be used for the 5 psi test. Permanent deformation will not be cause for failure unless accompanied by leakage.
- After installation, the complete installation will be tested too a head not less than that which the tank will be subjected to in service. Fuel may be used as the medium.
- Tanks not vented to atmosphere are to be tested as pressure vessels (section 54)

Section 72.01-25 of 46 CFR requires:

- Subdivision bulkheads, including steps, recesses, trunks, tunnels, ventilators, etc. which might form part of such bulkheads to be hose tested upon completion. The water pressure for hose testing will be 30 psi. It is not necessary to fill these compartments with water for testing.
- The forepeak, double bottoms, duct keels, and inner skins shall be tested upon completion of construction to a water head equal to the head it might be subjected to in the event of damage to the vessel.
- The watertight space enclosing the stern tube shall be tested by filling with water to a head up to the deepest subdivision load line.
- Tanks which are intended to hold liquids, and which form part of the subdivision, shall be tested for tightness upon completion with a water head up to the deepest subdivision load line or to a head corresponding to 2/3 of the depth from the keel to the margin line in way of the tanks, which ever is greater, but in no case shall the test head be lower than three feet above the top of the tank.

Section 39.20-11 requires that each tank pressure-vacuum relief valve must be tested for venting capacity with a flame screen fitted.

DNV rules regarding structural testing is stated in Part 3, Chpt. 1, Sec. 1, and is subdivided into 3 sections, Hydraulic tests, Air tightness tests, and hose testing.

Hydraulic tests -

- Protective coatings may be applied before water testing, but testing must be carried out before cementing.
- All pipe connections are to be fitted before testing.
- If engine bedplates are bolted directly on the innerbottom plating, the testing of the double bottom is to be done with the engine installed.
- All tanks and holds arranged to carry liquids are to be tested with a water head equal to the maximum pressure to which the compartment may be exposed. The water head is in no case to be less than the top of the air pipe or 2.5m above the top of the tank which ever is greater.
- Cargo tank bulkheads in tankers are to be hydraulically tested from at least one side. The testing is to be carried out in such a manner that the maximum allowable hull girder forces and bending moments are not exceeded.
- Upon approval from the supervisor, hydraulic tests may be replaced by air tightness tests. After the air tightness test, at least one of each type of structure tank or hold shall be hydraulically tested.
- If the hydraulic test reveals structural weakness or faults not detected by the air test, then all tanks will be hydraulically tested form at least one side. If minor leakage occurs during the original hydraulic test, an additional number of tanks will be tested until the Surveyor is satisfied.
- When water testing an a building berth is undesirable or impossible, testing afloat may be accepted. The testing is to be carried out by filling each tank separately to the test head.
- Inner and outer ports below the water line are to be hydraulically tested.
- Watertight access doors and hatches shall be hydraulically tested from the side most prone to leakage. This testing will be accomplished before installation, normally at the manufacturer’s shop.

Air Tightness Tests -

- Air tightness tests are to be carried out before final coating of welds.

- An efficient indicating liquid is to be applied. The pressure is to be maximum 20 kN/m^2 and is to be reduced to a smaller value before inspection. A safety valve and pressure gage are to be installed.

Hose Testing-

- Watertight decks, tunnels, trunks, duct keels, and ventilators are to be tested after completion. A hose or flooding test is to be applied to watertight decks, and a hose test is to be applied to trunks, tunnels, and ventilators.
- Watertight bulkheads - Testing watertight compartments by filling them is not compulsory, when testing by filling is not carried out, a hose test is compulsory. This test shall be carried out in the most advanced stage of fitting out the ship.

- Weathertight and watertight closing appliances not subjected to pressure testing are to be hose tested. Nozzle diameter is to be 12.5 mm and a pressure of at least 250k N/m^2, the nozzle shall be held at a max. distance of 1.5m. Alternative methods of tightness testing may be considered.
- All weathertight/watertight doors and hatch covers are to be function tested.
- Requirements for weathertightness may be dispensed with for ships exclusively carrying containers.

Specific Tank Testing Requirements

- All cargo tanks are to be subjected to a hydrostatic test and to a tightness test. Welds are not to be painted before testing.

Tank Testing Requirements			
	ABS	**46 CFR**	**DNV**
Hydrostatic testing	To highest point water can rise, pre or post-launch	To highest point water can rise in the event of damage	Water head equal to the max. press. to which tank may be exposed
Air Testing	2 psi (.137 Bar)	N/A	Max 20 kN/m^2
Hose Testing	> 30 psi (2.06 Bar)	30 psi	Nozzle dia 12.5mm@ 250k N/m^2, 1.5m away
Double Bottom Tanks	Hydro, Air, or Combo Test	Hydro Test	Hydro or Air
Deep tanks	Hydro, Air, or Combo Test	Hydro Test	Hydro or Air
Forepeak and Afterpeak	Hydro, Air, or Combo Test	Hydro Test	Hydro or Air
Ballast Tanks, Dry Cargo Vessels	Hydro, Air, or Combo Test	Hydro Test	Hydro or Air
Forepeak dry space	Hose Test	Hose Test	Hose Test
Duct Keels	Hydro, Air, or Combo Test	Hydro Test	Hose Test
Shaft Tunnels	Hose Test	Hose Test	Hose Test
Stern Tube enclosure	N/A	To be filled w/water	N/A
Chain Lockers (aft of forepeak bulkhead)	To be filled w/water	N/A	N/A
Hawse Pipes	Hose Test	Hose Test	Hose Test
Weathertight Hatchcovers & Closing Appliances	Hose Test	Hose Test	Hose Test
Oil Cargo Tanks, Tanker or Combination Carrier	Hydro, Air, or Combo Test	Hydro Test	Hydro or Air
Ballast Tanks within Cargo Tank Section	Hydro Test	Hydro Test	Hydro or Air
Ballast Tanks outside Cargo Tank Section	Hydro, Air, or Combo Test	Hydro Test	Hydro or Air
Chemical Cargo Tanks	Hydro Test	Hydro Test	Hydro or Air
Bulkheads at ends of Cargo Tank Sections	Hydro Test	Hydro Test	Hydro or Air
Boundaries of Tanker Segregated Cargoes	Hydro Test	Hydro Test	Hydro or Air
Void Space Boundaries Required to be Watertight	Hose or Air Test	N/A	N/A
Double Plate Rudders	Hydro, Air, or Combo Test	N/A	N/A
Independent Gas and Diesel Tanks	N/A	Pre-install - 5 psi or 1.5 times max. head. Post-install -Service head	N/A
Gas Carriers:			
Pressurized gas tanks (types B & C)	Hydro Test, 1.5 MARVS	Hydro Test	Hydro Test
Integral or Independent Tanks (types A & B)	Hydro or Hydrpneumatic Test to simulate design stress	Hydro Test	Hydro or Hydrpneumatic Test
Membrane Tanks	Subject to approval	N/A	Tightness test
Ballast or Fuel Oil Tanks Adjacent to or Between Cargo Tank Hold Spaces	Hydro Test	Hydro Test	Hydro or Air
Initial Service Tests, All Gas Carriers	Section 5/4A.1S.2	N/A	N/A

Table B - 17 - Tank Testing Requirements

- The test may be hydrostatic or hydropneumatic and shall be performed so that the stresses approximate the design stresses, and so that the pressure in the top of the tank corresponds to the MARVS.
- For ships with membrane or semi-membrane tanks, all spaces which may normally contain liquid and are adjacent to the hull structure supporting the membrane are to be hydrostatically or hydropneumatically tested. Each tank is also to be subjected to an adequate tightness test.
- Each independent tank is to be subjected to a hydrostatic or hydropneumatic test. Test pressure to correspond to tank type A, B, or C. Each tank is also to be subjected to a tightness test.

Trials, Inspection, and Sea Trials

46 CFR, Lloyd's rules, and the JIS all specifically address trials, inspection, and sea trials. Differences and similarities in the testing requirements of these agencies are outlined in Table B-18.

Sections 31.10-40 and 58.01-30 of 46 CFR address trial-trip observance. They state: " The operation of main and auxiliary engines, boilers, steering gear, and auxiliaries shall be observed on the trial trip of each new vessel and all deficiencies which affect the safety of the vessel shall be corrected to the satisfaction of the OCMI."

With regard to inspection, Lloyd's Rules require tests of components and trials of machinery, as detailed in the respective chapters are to be carried out to the satisfaction of the Surveyor.

In relation to Sea Trials, Lloyd's states the following requirements:

- For all installations, the sea trials are to be of sufficient duration, and carried out under normal maneuvering conditions, to prove the machinery under power. The trials are also to demonstrate that any vibration that might occur within the operating range is acceptable.
- The trials are to include demonstrations of the following:
  - Required number of starts for the main engine.
  - Ability of machinery to reverse thrust of propeller in sufficient time, under normal maneuvering conditions, and so to bring the ship to rest form maximum ahead speed. Results are to be recorded.
  - In turbine installations, the ability to permit astern running at 70% of the full power ahead revolutions without adverse affects. A test of 15 minutes is sufficient, but may be extended to 30 minutes at the surveyor's request.
- When controllable pitch propellers are used, the astern trial is to be performed with the blades in the full astern position. Emergency manual pitch setting features are to be demonstrated is applicable.
- For geared installations, prior to full power sea trials, the gear teeth are to be suitably coated to demonstrate contact, and the gears are to be opened upon return to permit the surveyor's inspection. Where the ship is provided with supplementary means for maneuvering or stopping, the effectiveness of such means are to be demonstrated and recorded.

Lloyd's also requires that the following items are to be tested on completion of installation or at sea trials:

- Sliding water tight doors - To be operated under working conditions.
- Windlass - An anchoring test is to be completed, and should demonstrate that the windlass with brakes, etc. functions properly, and that the windlass can develop enough power to raise the anchor from a depth of 82.5m to a depth of 27.5m at a speed of 9m/min.(Ch 13.7.6.3)
- Steering gear, main and auxiliary - To be tested to the satisfaction of the Surveyor in accordance with rule requirements of PT 5, Ch 19.
- Bilge suctions in holds, and hand pumps in peak spaces - To be tested under working conditions.

The JIS specifies the test methods of propulsion machinery at sea trials. The schedule of the trial and the kind of tests performed will be agreed upon prior to the trial by the concerned parties. The Test code is subdivided into two categories, "Kind of Test and Method of Trials", and "Measuring Items and Methods".

The “Kind of Test and Method of Trials” section includes:

- Mooring Trials (may be omitted if preliminary trials are planned)
- Running-in Trial (may be included in the preliminary trial)
- Preliminary Trial - (may be omitted at the discretion of the shipbuilder)
- Official Trial - (part of this trial may be included in the preliminary trial)
  1. Guarantee Speed Test
  2. Progressive Speed Test - (the Guarantee Speed Test may be covered by this test)
  3. Overload Test - (not usually required)
  4. Endurance Test - (other tests such as the Speed Test, the F.O. Consumption Test, the Steering Test, and the Turning Test may be carried out during this test as appropriate.)
  5. Fuel Oil consumption Test
  6. Astern Test -
  7. Minimum Rotational Speed Test
  8. Starting Test
  9. Unmanned Machinery Operation Test
  10. Other Tests (if necessary)
      - i) Shafting torsional vibration measurement
      - ii) Vibration measurement
      - iii) Noise Measurement
      - iv) Exhaust gas economizer evaporation measurement
      - v) Distilling Plant Capacity Measurement

The “Measuring Items and Methods” section includes:

- General Items
- Measurement of Rotational Speed
- Output Measurement
  1. Brake Output
  2. Shaft Output
- Pressure Measurement
- Temperature Measurement
- Fuel Oil Consumption Measurement
  - a) Measuring Equipment
  - b) Specific Fuel Oil Consumption
    - i) Actual Specific FO Consumption
    - ii) Correction of specific FO

Trials, Inspection, and Sea Trial Requirements			
	Lloyd s	**46 CFR**	**JIS**
Prove machinery under power	Yes	N/A	Speed Test
Ensure Vibration is acceptable	Yes	N/A	Optional
Overload Test	N/A	N/A	Optional
Endurance Test	N/A	N/A	Yes
F.O. consumption	N/A	N/A	Yes
Unmanned Machinery Operation	N/A	N/A	Yes
Shafting torsional vibration	N/A	N/A	Optional
Noise measurement	N/A	N/A	Optional
Exhaust gas economizer evap.	N/A	N/A	Optional
Distilling plant capacity test	N/A	N/A	Optional
Specific Measuring Items & Methods	N/A	N/A	Yes
Main Engine # of Starts	Yes	N/A	Yes
Reverse Thrust	Bring ship to rest	N/A	N/A
Astern Propulsion	Turbines only @ 70% for 15-30 min (If CPP, then blades in full astern pitch)	N/A	Yes
Gear tooth contact inspect.	Yes	N/A	N/A
Alternate Propulsion Systems	Yes	N/A	N/A
Sliding water tight doors	Yes - working conditions	N/A	N/A
Windlass	From 82.5m @ 9m/min.	N/A	N/A
Steering gear	Yes	N/A	N/A
Bilge Systems & hand pumps	Yes	N/A	N/A

Table B-18 - Sea Trial Requirements

consumption for diesel ships

iii) Correction of specific FO consumption for turbine ships

c) Standard Calorific Value

- Verification of Fuel Oil
- Electric Power Management

Turbines

All CSARB documentation deal with turbine testing except for CFRs. Table B-19 outlines the similarities and differences in the testing requirements.

Hydrotesting:

ABS, ASTM, and Lloyd's all deal with onboard hydrotesting. All CSARB bodies specify a hydrotest pressure of 1.5 times the maximum working pressure for pressurized portions of turbines. However, there is some specific hydrotest variations between CSARB bodies as outlined below:

ABS: Identifies turbine casings, reheater casings, accumulators, heat exchangers, maneuvering valves, and gas piping for testing up to 1.5 times working pressure [maximum].

Variable pressures (per design) throughout the turbine casing stages via temporary diaphragms is permitted.

The condenser side of the turbine will be tested to 15 psig.

ASTM: States any pressurized turbine parts containing steam or oil will be tested up to 1.5 times the design pressure with operating temperature up to 650 deg. F.(343 C). Special pressure calculations are required for operating temperatures above 650 F. Details on these calculations (which are based upon hoop stress) are in ASTM.

The condenser side shall be tested to 25 psig.

Test pressures are to be maintained for a minimum of 15 minutes.

LLOYD'S: Identifies nozzle boxes of impulse turbines are to be tested at 1.5 times the working pressure. Maneuvering valves are to be tested at 2 times the working pressure. Gas turbines require casing tests at 1.5 times the maximum working/ starting pressure developed. Subdivisions between casings are permitted for distribution of test pressure.

Cylinders are to be tested up to 1.5 time the working pressure or 2 bar (30 psi), whichever is the greater. Variable pressures (per design) throughout the turbine casing stages via temporary diaphragms is permitted.

Condensers are to be tested to 15 psig.

DNV**:** No hydrotesting specified, strictly operational testing.

JIS: No hydrotesting specified, strictly operational testing.

Operational Testing:

ABS, DNV and JIS all deal with onboard turbine testing.

ABS**:** Upon onboard testing of the turbine, installation and safety of operation are to be demonstrated to an ABS inspector. Additionally, for geared propulsion turbines over 1500 HP, a record of gear tooth contact is to be on site during the inspection. ABS also has a special section 5/1 for turbines operating in ice conditions.

ASTM**:** There is no ASTM onboard testing. But, there is an initial ASTM in shop, no load running test @ rated operational speed and available steam conditions. Observations during the no load test include: general mechanical operations, shaft vibration, governor valve setting and operation, overspeed trip setting, steam and oil tightness, bearing and lubricating oil temperature rise, and safety devices. *This test criteria was included because it may lend itself to development of onboard turbine testing.*

LLOYD'S**:** There is no onboard testing. The only tests are done in the shop before installation.

DNV**:** Onboard testing of steam turbines basically covers vibration and lubrication oil filters being examined visually.*[Visual inspection of lubricating oil systems has been deemed insufficient by today s fluid analysis standards].*

DNV has an extensive gas turbine onboard testing agenda and accompanying forms. Pt. 4 Ch. 2 Sec. 4 page 17. 103 states that prior to any initial testing, functionality of alarms and controls (and their set points) and safety systems combined w/ leak checks must be accomplished.

A preliminary test run should be conducted followed by a boroscope inspection for blade nicks, etc. For gas turbines the following are recorded: vibration, false start & fuel pump valve operation,

performance of fuel treatment system, and follow on visual or boroscope inspection. Auxiliary gas turbines are outlined with the following test criteria relating only to onboard testing: (page 17, pt. 4 ch. 2 sec. 4)
-transfer functions for control of turbine parameters.
-results of open and closed loop simulation of turbine control parameters.
-calculation of turbine response to an instantaneous loss of 100% load and the driven inertia.
-torsional vibration analysis for long or slender gas turbine shafting.
-axial vibration analysis in the case of a relatively unbalanced axial rotor system.
-torsional vibration calculations of power turbine shafting system, including impact vibration calculations.
-calculation of turbine response to load variation: from full load to no load w/ varying time constants, and from zero to full load for a series of different ramp functions.

It should be noted that DNV has defined "Type" testing and certification regulations. These two areas can be referred to for ideas to help in writing a standardized regulation for onboard testing of turbines. Refer to page 18, Pt. 4 Ch. 2 Sec. 4. for details.

JIS: This has the most detailed set of onboard trials tests out of all the CSARB bodies. The major items covered are: (see the detailed table pg. 87)

1. Ahead running test
2. Astern running test
3. Emergency shutdown device test
4. maneuvering valve test
5. Turning gear test
6. Vibration measurement
7. Noise measurement
8. Turbine casing expansion measurement
9. Lubricating oil flow measurement

*Some CSARB allow room for alternative tests if submitted for review prior to testing.

Vibration Levels

Testing for allowable vibration levels is addressed by the DNV rules, JIS, and ABS Guidance notes. Differences and similarities in the testing requirements of these agencies are outlined in Table B-20.

The DNV Rules outline standards of allowable vibration limits. These vibration limits are given in vibration velocity, peak amplitude, and apply to the maximum single frequency component of vertical, fore and aft, and athwartship vibration which is to be assessed separately. The DNV Rules do not address instruments, test methods, measuring points or procedures.

Similar to the DNV Rules, The ABS Guidance notes also outline standards of allowable vibration limits. The ABS Guidance notes also do not address instruments, test methods, measuring points or procedures.

The JIS addresses allowable vibration for accommodation areas and for ships machinery. For accommodation areas:
The conditions will be as follows-

- The ship running straight in calm water fully loaded or ballasted.
- Propulsion machinery running at normal output with essential auxiliary equipment for propulsion and misc. other equipment normally in operation. Intermittently operated equipment shall not be run.

The measuring instruments shall be well calibrated analog instruments whose outputs are linear within the frequency ranges measured.

The measuring points should be in spaces that are normally occupied by crew members, and measurements should be taken in the vertical, longitudinal, and transverse directions.

Measurements are to be taken for at lest 30 seconds, preferably for one minute.

For machinery areas, allowable vibration limits are divided into five categories, diesel engines for generators, pumps, air compressors, oil purifiers, and ventilating fans.

Measurements for machinery vibration shall be taken at the manufacturer's shop, and also after the shipboard installation is complete. Measurements for vibration at sea trails shall be taken only as necessary.

- Measurements at shop trial shall be taken at the rated operating condition, measurements of foundation vibration shall be taken as necessary.
- Measurements onboard or at sea shall be taken at the same points, under comparable operating conditions to the shop tests. When at sea the following conditions should be met:
    - Water depth of 5 times or more than the ship's depth.
    - Calm sea state.
    - operating ballast conditions, propeller submerged.

Vibration Levels Test Requirements			
	DNV	**ABS**	**JIS**
Specific Test Conditions	N/A	N/A	Yes
Specified Measuring instruments	N/A	N/A	Yes
Specified Measuring Points	N/A	N/A	Yes
Specified Allowable Limits	Yes	Yes	Yes

Table B-20 - Vibration Level Measurement Requirements

Watertight Bulkheads, Decks, and Recesses (Hose Testing)

The ABS, Lloyd's Register, and the USCG Marine Safety Manual address testing of watertight closures, specifically, hose testing. The ABS rules state that hose testing is to carried out under simultaneous inspection of both sides of the joint. The pressure in the hose is not to be less than 2.06 bar (2.1 kgf/cm^2, 30 psi).

Lloyd's Register requires a hose pressure of at least 2.0 bar (2.0 kgf/cm^2) at a maximum distance of 1.5m from the item under test. The following items are to be hose tested:

- watertight doors, in place
- watertight bulkheads, tunnels, flats, and recesses
- bow, side, and stern doors
- weathertight doors and other weathertight closing appliances
- weathertight steel hatch covers

The Marine Safety Manual allows testing of closures by means of light testing, pressure testing, or hose testing. Watertight closures shall be tested under design pressure where practicable, otherwise a hose test over 30 psi may be accepted. Weathertight fittings should be hose tested for several minutes and allow no more than a slight seepage of water to pass. An operational test shall be performed on hatch cover closure devices.

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Task 2 - Factors to Determine Testing at the Optimal Stages of Construction

NSRP 0534 Project 6-95-1

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Introduction/Abstract

The information compiled in Task 1 provides a useful foundation upon which an effective test plan and test procedures can be developed. However, to further define a commercial standard test plan and test procedures, it is also necessary to look at the factors which influence test programs. These factors include current industry practices regarding testing, and Classification Society and Regulatory Body (CSARB) rules that create barriers restricting testing to specific phases of construction. The focus of Task 2 is to investigate these factors and determine the most efficient testing methods within the parameters set forth by the CSARBs.

Objective

The Regulatory Body Test Requirement Matrix developed in Task 1 compared and contrasted the worldwide regulatory bodies requirements for testing a commercial ship. The team found that while each varied in their approach to ship testing, the overall result of testing a ship was fairly similar. However, the ABS breakdown structure, as well as the other CSARB structures, do not effectively parallel a systems breakdown for a commercial ship. Task 2 investigates the typical systems found on a commercial ship and identifies the optimum stages of construction for testing. Once compiled and analyzed, this information will be utilized in writing the standard test plan and test procedures necessary to accomplish Task 3.

The feasibility of testing each system in the optimum stage of construction (earlier or later in the construction plan), is based on the following factors:

- CSARB barriers restricting testing to specific phases of construction.
- System design issues that require certain portions of systems to be completed prior to testing such as piping, alignments, electrical wiring, etc.
- Documentation requirements of CSARBs for incremental testing and final acceptance.

Approach and Rationale

In order to better analyze system testing requirements, the project team identified a list of representative systems found on a typical commercial ship. Attachment A of this report, entitled *System Testing and Inspection Requirements,* represents a comparative analysis of the pertinent system test requirements. The descriptive breakdown of each system reflects those factors that determine the extent and timing of testing.

The *Comments* section of each page identifies the types of tests and inspections performed by other shipyards currently building commercial ships worldwide. A separate Test Procedure Comparison Matrix, included as Attachment B of this report, was created to quickly compare what types of testing are accomplished by each representative yard. This information was then transcribed into the C*omments* section of each system.

The *Recommendations* section of Attachment A identifies the team's recommendations as to which types of tests, if any, are needed to satisfy all CSARB requirements for a particular system. Based on the information gathered, recommendations to include certain tests, and to move other tests to in-process inspections, were made. This information will be the basis for the development of the test plan and test procedures in Task 3.

To further define the specific system design issues influencing testing, Gantt charts were developed. The Gantt charts, included as Attachment C, outline major phases of vessel construction and represent the interrelationship between major testing evolutions. The ship systems were grouped into larger classifications, from which the Gantt charts were created. The top two lines of each Gantt chart contain the ships' milestones and key dates. The milestones show major ship evolutions that pertain to ship testing while the key dates show the various phases of construction. The milestones chosen are as follows:

- Launch or Undocking of the ship,
- Shore power to the switchboard,
- Emergency Diesel Generator start,
- Main Diesel Generators start,
- Inclining Experiment,
- Dock Trials,
- Sea Trials, and

- Delivery.

The key dates identified show four phases of ship construction:

- Steel assembly,
- On-ground or on-unit outfitting,
- On-board outfitting, and
- Test.

Below the key dates are three fields depicting the pertinent installations, inspections, and testing of the classification groups. A *Notes* section explains the predecessor and successor relationship logic of the events portrayed in the charts. The chart is a useful tool in determining effective and efficient test sequencing for scheduling purposes.

Findings

From the information collected during the research efforts of Task 2, recommendations with regard to specific system and component testing were suggested. Considering the CSARB requirements and applicability of testing during certain phases of construction, suggestions to include certain tests or to move other tests to in-process inspection have been made. The team will develop a test plan and a set of test procedures that reflect these findings.

Applicability to Other Tasks

The document provided as Attachment A identifies regulatory barriers that restrict testing to specific phases of construction and defines which test procedures are required to satisfy both the CSARB and the shipbuilder’s requirements. Development of the test plan and test procedures required for Task 3 will be directly related to the information contained in Attachments A, B, and C. Additionally, the computer database for tracking test requirements to be developed in Task 4 will incorporate the information contained in Attachments A, B, and C.

Attachments:

(A) System Testing and Inspection Requirements (101 sheets)
(B) Test Procedure Comparison Matrix (5 sheets)
(C) Test and Inspection Gantt Charts (9 sheets)

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Task 2 - Factors to Determine Testing at the Optimal Stages of Construction

Attachment A - System Testing and Inspection Requirements

Test Procedure Title: Propulsion System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/3.39	Before final acceptance, the entire installation, including shafts, gears, etc., is to perform satisfactorily under operating conditions in the presence of the Surveyor.
LR 5/5.5.2 5/1.5.2	For all types of installations, Sea Trials are to be of sufficient duration to prove machinery under power.
DNV 4/2-12	After conclusion of running in program prescribed by the engine manufacturer, the main propulsion engines are to be tested at Sea Trials.
JIS 0801-89	JIS specifies the test methods of propulsion machinery to be carried out at Sea Trials for new ships. Tests include guarantee speed, progressive speed, endurance, fuel oil consumption, astern, minimal rotational speed, starting, and unmanned machinery operations. Other measurements, including shafting torsional vibration, vibration, noise, and exhaust gas economizer evaporation, shall be performed only if necessary. An overload test may be carried out in the case of an internal combustion engine.
CFR 58.01-30	The operation of the main engine and its auxiliaries shall be observed on the trial trip of each new vessel and all deficiencies which affect the safety of the vessel shall be corrected to the satisfaction of the Officer in Charge.

Comments:

- At Dock Trials, prove the functionality of the plant and associated auxiliary systems.
- At Sea Trials, prove installations and operations of the propulsion machinery under various conditions, including all alarms and safety devices.
- Post Sea Trials inspection of lube oil systems for foreign matter.
- Propulsion testing is varied for all other yards, both foreign and domestic. Foreign yards perform the bulk of their testing during Dock Trials.
- A test procedure for propulsion testing exists for all yards.

Recommendation:

The required propulsion systems testing and inspections can be addressed in the Dock Trials and Sea Trials test procedures, or it can be addressed in a separate test procedure.

Test Procedure Title: Reduction Gears

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/3.29 4/3.39	Before final acceptance, the entire installation, shafts, gears, etc., is to perform satisfactorily under operating conditions in the presence of the Surveyor. Post trial examination of the gears is to indicate essentially uniform contact across 90% of the effective face width of the gear teeth excluding end relief.
DNV 4/2-28	Reduction gear mounting and the functionality of the lube oil system is to be inspected/verified by Surveyor. If possible, gear mesh inspection is to be repeated after complete installation, including shaft connections.
LR 5/5.2.5	A permanent record is to be made of the meshing contact for purpose of checking the alignment when installed on board ship. In the case of separately mounted reduction gearing for main propulsion, means are to be provided to enable the Surveyor's to verify that no distortion of the gearcase has taken place, when chocked and secured to its seating on board ship.
DNV 4/2-28	Visual inspection of the mounting of the gear on its foundation and the functioning and monitoring of the lube oil system for the reduction gear is to be verified by the Surveyor. If mesh inspection is possible in assembled condition, it is to be performed after completed installation, including connection of all shafts. Oil temperature and casing temperature in way of bearings are to be checked during the full load test. After Sea Trials, the gear teeth are to be inspected by the Surveyor for possible wear marks or scuffing. Shrunk on rims are to be inspected for possible movement relative to the hub and accessible rolling bearings are to be inspected for possible rotation of outer rings.

Comments:

- Prior to Sea Trials, reduction gear mounting and teeth mesh contacts and the functionality of the lube oil system are to be inspected.
- At Sea Trials, demonstrate proper installations and operations of entire installation while operating under normal conditions.
- After Sea Trials, the gear teeth are to be inspected for possible wear marks or scuffing and shrunk on rims and accessible rolling bearings are to be inspected for possible unacceptable movements.

Recommendation:

A separate test procedure may be written for the reduction gear to address pre-trials, Sea Trials, and post trials testing and inspections.

Test Procedure Title: Shafting alignment

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/2-29	When shaft alignment calculations have been approved, alignment is to be verified by measurements in presence of the Surveyor, normally in afloat conditions.
ABS 4/7.33.6	If alignment calculations are required for submittal, they are to be verified and recorded at Sea Trials by appropriate measurement methods, along with any proposed barred speed ranges within the engine operating range, in the presence and to the satisfaction of the Surveyor.
LR 5/8.5.4	Where calculations indicate that the system is sensitive to alignment changes under service conditions, the optimized shaft alignment is to be verified by measurements using an appropriate technique.

Comments:

- While in afloat conditions, demonstrate alignment of shaft bearings.
- If alignment calculations are required, they are to be verified at Sea Trials by appropriate measurement techniques.
- All other yards, both foreign and domestic, have shafting alignment as an inspection, not a test procedure.

Recommendation:

Shafting alignment should be part of a quality inspection process.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Machinery Sea Water Cooling System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other yards, both foreign and domestic, test the machinery sea water cooling in a test procedure.

Recommendation:

A test procedure for the sea water cooling system should be written to show system operations under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Machinery Plant Handling Padeyes and Monorails

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Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 3410-90 0802-89	A visual inspection of the handling padeyes are to be performed, examining the quality of the welds and the absence of sharp material edges on the padeye. For monorails, the deflection of the center of the girder shall be measured at the rated load and at 125% load.
ABS Survey of Cargo Gear on Merchant Vessels	No specific requirements for handling padeyes or monorails. Section 3.3.1 of the ABS Survey provides a list of proof loads that act as the test criteria for cargo handling gear.

Comments:

- After installation, perform a visual inspection of the padeyes.
- Prior to Sea Trials, the deflection of the monorails should be measured.
- Neither the foreign nor the domestic yards test the handling padeyes or the deflection of the monorails in a test procedure.

Recommendation:

For handling padeyes, we recommend performing a visual inspection. For the deflection of the monorail, we propose to test it as part of a crane test procedure.

Test Procedure Title: MDG/Auxiliary Boiler/Incinerator Exhaust System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
CFR 56.97	An initial service leak test and inspection is acceptable when other types of tests, such as hydro or pneumatic, are not practical.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, perform an initial service visual inspection under working conditions to demonstrate system tightness.
- Other yards, both foreign and domestic, perform an initial service exhaust inspection.

Recommendation:

A separate test procedure is not required, the exhaust piping can be addressed in the Piping Hydrostatic Test Procedure. For the exhaust systems, we recommend tracking pipe section hydrostatic tests during construction and a final leak inspection under working conditions to prove tightness accomplished during Sea Trials.

Test Procedure Title: Lube Oil Fill/Transfer and Purification System

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Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 6601-89	Covers a variety of operational tests of the oil purifier, all of which can be accomplished as shop tests simulating operating conditions.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations.
- Other yards, both foreign and domestic, test the lube oil fill, transfer, and purification system in a test procedure.

Recommendation:

A test procedure for the lube oil fill, transfer, and purification system should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Main Propulsion Lube Oil System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other yards, both foreign and domestic, test the main propulsion lube oil system in a test procedure.

Recommendation:

A test procedure for the main propulsion lube oil system should address pre-trials testing of the system operating under normal working conditions.

Test Procedure Title: Starting Air Compressors and System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4.2-52	All parts subject to pressure of the compressors are to be hydraulically pressure tested to 1.5 times the design pressure, not to exceed the design pressure by 70 bars. After on-board installation, compressor and connecting systems are to be function tested under working conditions, including all control and safety functions.
JIS 0801-89	Start the main engine as many times as possible from the air reservoir without replenishment. Record the number or starts and the pressure in the reservoir at each start.
ABS 4/6.7.5 4/6.7.8	Piping is to be tested, preferably before installation, to 1.5 times the design pressure. After installation, all piping is to be tested under working conditions.
LR 5/1.5.2	Demonstrate on Sea Trials that the starting arrangements provide the required number of starts of the main engines adequately.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- At sea, test the number of main engine starts from the air reservoir, without replenishment, to see if the required number of starts is adequately provided.
- Other yards, both foreign and domestic, test the starting air compressors in a test procedure.

Recommendation:

A test procedure for the starting air compressor system should address pre-trials testing. Air start systems are also tested during Sea Trials.

Test Procedure Title: Ship Service and Control Air Equipment

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other yards, both foreign and domestic, test the ship service and control air equipment in a test procedure.

Recommendation:

A test procedure for the ship service and control air equipment should address pre-trials testing.

Test Procedure Title: Segregated Ballast System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system tightness and pump operations by pumping to, and taking suction from, the ballast tanks.
- At sea, prove systems operations, including all controls and safety devices, by ballasting and deballasting the ship to required draft conditions.
- Other yards, both foreign and domestic, test the segregate ballast system in a test procedure.

Recommendation:

A test procedure for the segregated ballast system should address pre-trials testing. Segregated ballast systems are also tested during Sea Trials.

Test Procedure Title: Steam and Condensate System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
LR 5/12.7.2 5/1.5.1.1	Heating coils are to be tested by hydraulic pressure after on-board installation. Tests of components and trials of machinery for individual systems are to be carried out to the Surveyors satisfaction.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.2 4/6.7.8	Steam piping is to be tested, preferably before installation, to 1.5 times the design pressure. Pipe joints welded on the ship are also to be tested to 1.5 times the design pressure, if practicable. After installation, all piping is to be tested under working conditions.

Comments:

- Prior to Sea Trials, demonstrate proper system tightness and operations, including all controls and safety devices.
- Verify service to other systems and equipment.
- Other yards, both foreign and domestic, test the steam and condensate system in a test procedure.

Recommendation:

A test procedure for the steam and condensate system should address pre-trials testing.

Test Procedure Title: Fuel Oil Quick Closing Valves

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/1- 41,42	After installation, class 1 &2 fittings are to be hydrostatically tested to 1.5 times the design pressure. All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
JIS 7457-89	For a pneumatically operated fuel oil shut-off valve, the valve shall have no trouble in operation.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, satisfactorily demonstrate the operational ability of each quick closing valve.
- Other yards, both foreign and domestic, have the FO quick closing valves in a test procedure.

Recommendation:

A test procedure for the FO quick closing valves should address pre-trials testing.

Test Procedure Title: High/Low Temperature Fresh Water Cooling System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system tightness and operations, including all controls and safety devices.
- Verify service to other systems and equipment.
- Other yards, both foreign and domestic, test the HT/LT fresh water cooling system in a test procedure.

Recommendation:

A test procedure for the HT/LT fresh water cooling system should address pre-trials testing of the system operating under normal working conditions.

Test Procedure Title: Stern Tube Lube Oil System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system tightness and operations, including all controls and safety devices.
- Other yards, both foreign and domestic, test the stern tube lube oil system in a test procedure.

Recommendation:

A test procedure for the stern tube lube oil system should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Electric Power Insulation Resistance

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 111.60-21	References the requirements of IEEE45 section 46.2.1
ABS 4/5/B3.3	Stated requirements are for power and lighting circuit insulation resistance readings. Reference chart for minimum resistance readings between conductors, and between conductors and ground.
IEEE45-46.2.1	Stated requirements are for power and lighting circuit insulation resistance readings. Reference chart for minimum resistance readings between conductors, and between conductors and ground.
LLOYD 6/2/20.2.2	Stated requirements are for all electrical circuits to have insulation resistance readings. Reference chart shows readings between conductors, and between conductors and ground to be minimum of 1 meg ohm.
JIS 8072-86 (IEC 92-401/7/58,59)	Requires insulation readings of greater than 1 meg ohm on all outgoing circuits. Main, emergency, and distribution switchboards also require a resistance reading of 1 meg ohm before being put into service.
DNV 4/4/9/E 301, 303	Requires insulation readings of greater than 1 meg ohm on all outgoing circuits. Main, emergency, and distribution switchboards also require a resistance reading of 1 meg ohm before being put into service.

Comments:

- Insulation resistance testing should be performed throughout the production window, and must be complete before power is applied to circuits.
- The insulation resistance test/inspection should be conducted by the installing activity after both ends of cable are hooked up.
- Timing of test plays a major part in cost and schedule. Starting too early will waste time and starting too late will delay schedule.

Recommendation:

A common inspection format should be developed to identify which circuits are to be checked. Data sheets can be pre-printed with circuit numbers, or circuits can be written in as checked. A test procedure is not required provided an in-process inspection and documentation procedure exists. The readings recorded on the check sheets would be sufficient if documentation is required by Owner or CSARB.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Electrical Protective Devices

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21.1, 4/5C6.1 IEEE45 46.2.3 LLOYD 6/2/20.2.4 JIS 8072-86(IEC 92-401/11/61) DNV 4/4/E 302	All agencies reference the use of manufacturer's certifications and/or applicable standards (UL approval, etc.) All CSARB's have a general statement with regard to operating all main switches and circuit breakers (not necessarily at full load), or to demonstrate that the rules have been complied with.

Comments:

- No agency requires direct shipboard tests for circuit breakers.
- The majority of the shipyards benchmarked did not have a test memo related to circuit breakers.
- It appears that most shipyards have an in-process inspection and verification procedure.

Recommendation:

A test procedure is not required provided that an in-process inspection and documentation procedure exists to document operational verification. Equipment certifications from manufacturers should serve in lieu of operational testing.

Test Procedure Title: Ship Service Generator Installation Tests

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Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 111.12-5	References ABS section 4/5 requirements
ABS 4/5C2.5 IEEE45- 46.2.2 JIS 8072-86(IEC 92-401/11/62) LLOYD 6/2/20.2.4 DNV 4/4/9/E 203	All societies require insulation resistance checks before operation and immediately after operation (cold & hot megger readings). Minimum reading calculations vary from society to society.

Comments:

- All shipyards benchmarked perform this function along with load testing of generators.
- A separate test memo is not required.

Recommendation:

Expand the scope of the ship service generator operational test memo to include insulation resistance checks. Testing may start only after all associated equipment, as well as primary equipment, has been installed and is ready to test as a total system.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Ship Service Generator Operational Test

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Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 111.12-5 to 12.7	References ABS section 4/5 requirements
ABS 4/5.21.1, ABS 4/5C2.3 through...	ABS requires.... "each generator to be run a time sufficient to show satisfactory operation, and parallel operations, with all possible combinations to be demonstrated."
IEEE45- 46.2.2	IEEE requires all safety devices to be demonstrated. A full load operational run of no less than 4 hours and a demonstration of parallel operations are also required.
JIS 8072-86(IEC 92-401/11/60)	All other societies require the same basic items. i.e.; safety checks, governor and voltage controls, load test demonstrations, etc.
LLOYD 6/2/20.2.4	
DNV 4/4/9/E 200 through 202	

Comments:

- The generator operational test memo has many variations between shipyards.
- Some shipyards test early in the production cycle, some later.
- The main issue appeared to be that all shipyards test only after the system is complete.
- A complete system includes MCCS functioning as well as the completion of generator auxiliaries and switchboards.
- Additionally, most shipyards do not divide their test procedure into separate test procedures such as installation, operational, etc.

Recommendation:

Expand the scope of the ship service generator operational test procedure to include insulation resistance checks. Testing may start only after all associated equipment, as well as primary equipment, has been installed and is ready to test as a total system**.**

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Emergency Diesel Generator

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 111.12-5 to 12.7	References ABS requirements
ABS 4/5.21.1 ABS 4/5C2.3 through...	ABS requires.... "each generator to be run a time sufficient to show satisfactory operation, and parallel operations, with all possible combinations to be demonstrated."
IEEE45- 46.2.2	IEEE requires all safety devices to be demonstrated. A full load operational run of no less than 4 hours and a demonstration of parallel operations are also required.
JIS 8072-86(IEC 92-401/11/60)	All other societies require the same basic items. i.e.; safety checks, governor and voltage controls, load test demonstrations, etc.
LLOYD 6/2/20.2.4	
DNV 4/4/9/E 200 through 202	

Comments:

- Most shipyards benchmarked combine emergency generator testing with main generator testing.
- An important concern is to determine at what stage in the production process emergency generator testing can occur.
- Because the same requirements exist for emergency generators and main generators, (with exception of parallel operations), it may be advantageous to schedule these tests concurrently.

Recommendation:

Determine if it is possible to include the emergency diesel generator with the ship service generator operational test. A separate test procedure is only required if the emergency generator testing can not be combined with the main generator testing.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Batteries and Chargers

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21.1 IEEE45 -46.1 JIS 8072-86(IEC 92-401/11/56) LLOYD 6/2/20.2.4 DNV 4/4/9/E/401	There is no specific requirement for testing. The generic testing statement of performing operational checks to the satisfaction of the Surveyor applies.

Comments:

- Test memo requirements solely depends on the type of equipment installed.

Recommendation:

A test memo should be developed based on operation of equipment.

Test Procedure Title: Transformers

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46 CFR 111.20 ABS 4/5.21.1, 4/5B3.3 IEEE45 44.7 JIS 8072-86(IEC 92-401 LLOYD 6/2/20.2.4 DNV 4/4/9/100	There is no specific requirement for testing. A generic testing statement regarding operational checks to the satisfaction of the Surveyor applies.

Comments:

- There are no requirements for testing transformers individually.
- Insulation resistance checks should be completed as equipment is installed.
- All auxiliary apparatus is to tried under working conditions.
- Insulation resistance checks are required on feed and output cables.
- Insulation resistance checks can be documented on the Electric Power Insulation Resistance Test Procedure.
- Factory certification should be obtained as requested.
- Standard operational verification while operating; i.e.; excess humming, excess heating, etc.
- Only one shipyard benchmarked appeared to assign a separate test procedure for transformers.

Recommendation:

A separate test procedure for the transformers is not required. The insulation resistance checks should be performed on the Electric Power Insulation Resistance Test Procedure. Any operational inspections should be done during a final walk through and during Sea Trials.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Electrical Instruments

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46 CFR	No testing requirements found.
ABS	No testing requirements found.
IEEE45	No testing requirements found.
JIS	No testing requirements.
DNV	No testing requirements.
LLOYD 6/2/7.18	Lloyds states factory testing should be performed.

Comments:

- No direct requirements to calibrate meters.
- Several CSARB's referenced how to construct and where to locate meters and tolerance requirements.
- Only one shipyard benchmarked has test procedure for Electrical Instruments.
- All others use in-process procedures and verification processes

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Recommendation:

No requirement for a Test Procedure. Tolerances (calibration) should be verified through certification records provided by the manufacturer, or by shipyard's calibration process.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Switchboards and Circuit Breakers

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5C4.3.1.e	The ABS has a general statement requiring operation of all main switches and circuit breakers, but not necessarily at full load.
IEEE 46.2.3	IEEE states that all switches, breakers, and associated equipment be demonstrated.
JIS 8072-86 (IEC 92-401)	JIS refers to IEC standards that require operational checks as close as practical to working loads.
LLOYD 6/2/7.18.3	Lloyds states factory testing should be performed to complete this requirement.
DNV 4/4/9/E302	States that the devices be verified satisfactory when found necessary by the Surveyor. Short circuit testing may also be required.

Comments:

- The Switchboard and Circuit Breaker Verification Test Procedure combines switchboard inspections with breaker trip test/verifications.
- Depending on design, operating devices could be located on switchboard, load shedding, generator controls, etc.
- All shipyards benchmarked have some version of this test procedure.
- Most shipyards use the Switchboard and Circuit Breaker Verification Test Procedure to verify breaker installation throughout the ship.

Recommendation:

A separate test procedure is required. The Switchboard and Circuit Breaker Verification Test Procedure is commonly used as a catch all for electrical equipment requirements on switchboards and main circuit breaker tests. Depending on the type of vessel and generator/switchboard configuration, the Switchboard and Circuit Breaker Verification Test Procedure should be design accordingly. Additionally, it may be advantageous to develop in-process procedures for circuit breaker verification purposes.

Test Procedure Title: Lighting Systems Insulation Resistance

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 111.60-21	References the requirements of IEEE45, section 46.2.1.
ABS 4/5/B3.3	Stated requirements are for power and lighting circuit insulation resistance readings. Reference chart for minimum resistance readings between conductors, and between conductors and ground.
IEEE45-46.2.1	Stated requirements are for power and lighting circuit insulation resistance readings. Reference chart for minimum resistance readings between conductors, and between conductors and ground.
LLOYD 6/2/20.2.2	Stated requirements are for all electrical circuits to have insulation resistance readings. Reference chart shows readings between conductors, and between conductors and ground to be minimum of 1 meg ohm.
JIS 8072-86 (IEC 92-401/7/58,59)	Requires insulation readings of greater than 1 meg ohm on all outgoing circuits. Main, emergency, and distribution switchboards also require a resistance reading of 1 meg ohm before being put into service.
DNV 4/4/9/E 301, 303	Requires insulation readings of greater than 1 meg ohm on all outgoing circuits. Main, emergency, and distribution switchboards also require a resistance reading of 1 meg ohm before being put into service.

Comments:

- The majority of shipyards benchmarked did not have a separate test procedure for Lighting Systems Insulation Resistance.
- Most shipyards combine Lighting Systems with the Electric Power Insulation Resistance Test Procedure.
- Lighting system insulation resistance testing is performed throughout the duration of construction and must be complete before power is applied to circuits for other testing.

Recommendation:

A separate test procedure is not required. The requirements for lighting systems should be incorporated into the Electric Power Insulation Resistance Test Procedure. This test should be conducted by the installing activity after both ends of cable are hooked up.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Lighting System Operational Test

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21.1 IEEE45 46.2.5 JIS 8072-86(IEC 92-401/7/63) LLOYD 6/2/20.2.6 DNV 4/4/9/E100.	All CSARB's require an operational verifications, generally expressed as a generic test statement.

Comments:

- Lighting system operational testing can be performed at earliest opportunity.
- All insulation resistance testing must be complete.
- Emergency lighting verification can be performed under this test memo.

Recommendation:

A test procedure should address operation of all lighting including emergency lighting. There are no requirements for a photometric survey.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: MCCS Insulation Resistance Tests

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 111.60-21	References the requirements of IEEE45, section 46.2.1
ABS 4/5/B3.3	Stated requirements are for power and lighting circuit insulation resistance readings. Reference chart for minimum resistance readings between conductors, and between conductors and ground.
IEEE45-46.2.1	Stated requirements for power and lighting circuit insulation resistance readings. Reference chart provides minimum resistance readings between conductors, and between conductors and ground. Part 2 on interior communication states for each circuit of 115v and above, insulation resistance should be at least 1 meg ohm, and for circuits below 115 v, insulation resistance should be above 1/3 meg ohm.
LLOYD 6/2/20.2.2	Stated requirements are for all electrical circuits to have insulation resistance readings. Reference chart shows readings between conductors, and between conductors and ground, to be minimum of 1 meg ohm.
JIS 8072-86 (IEC 92-401/7/65,66)	Each circuit operating at a voltage of 55 v and above shall have insulation resistance reading of greater then one meg ohm. Below 55 v shall have insulation reading of greater than 1/3 meg ohm.
DNV 4/4/9/E303	Insulation resistance is applied to every outgoing circuit, with a minimum attainable value of 1 meg ohm. This applies to instrumentation and communication circuits with voltages above 30 volts ac and above 50 volts dc.

Comments:

- Generally, the U.S. shipyards benchmarked require only circuits over 115 volts ac to be verified.
- The MCCS insulation resistance readings are usually combined with other insulation resistance checks.
- None of the shipyards benchmarked used a test procedure for MCCS insulation resistance testing.
- An in-process procedure should be in place to satisfy the above requirement.

Recommendation:

A separate test procedure is not required, provided an in-process procedure is in place. The readings recorded on the check sheets would satisfy the need for documentation.

Test Procedure Title: MCCS Design Verification Tests

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 61.40, 62 ABS 4/11.1.5 JIS 8076-86 (IEC 92-504) LLOYD 6/1/7 DNV 4/5	There is a large amount of information concerning MCCS design and testing. It is not practical to summarize the requirements of the individual CSARB's. Each CSARB has complete sections addressing MCCS operations and testing. It is necessary to determine a ship type before comparing the CSARB requirements for MCCS testing.

Comments:

- The MCCS Design Verification Test Procedure should be customized to suit a particular ship type and contract.
- The MCCS Design Verification Test Procedure requires all systems to be fully operational to verify fault/recovery analysis.
- A specific test procedure requirement exists for all CSARB's.

Recommendation:

The MCCS Design Verification Test Procedure should be written by MCCS vendor. It will require fault analysis and equipment failure predictions, and should be performed after all systems have been proven operational, usually after Sea Trials.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: MCCS Calibration and Alarms

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 61.40, 62 ABS 4/11.1.5 JIS 8076-86 (IEC 92-504) LLOYD 6/1 DNV 4/5	There is a large amount of information concerning MCCS design and testing. It is not practical to summarize the requirements of the individual CSARB. Each CSARB has complete sections addressing MCCS operations and testing. It is necessary to determine a ship type before comparing the CSARB requirements for MCCS testing.

Comments:

- The MCCS Calibration and Alarms Test Procedure demonstrates all the instrumentation, calibration and alarm set points.
- The MCCS Calibration and Alarms Test Procedure should be customized to a particular ship type and contract.

Recommendation:

The MCCS Calibration and Alarms Test Procedure should be a separate test procedure; however, the scope should be reviewed closely to ensure there are no duplications from individual equipment test procedures.

Test Procedure Title: MCCS Controls and Operation

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 61.40, 62 ABS 4/11.1.5 JIS 8076-86 (IEC 92-504) LLOYD 6/1 DNV 4/5	There is a large amount of information concerning MCCS design and testing. It is not practical to summarize the requirements of the individual CSARB. Each CSARB has complete sections addressing MCCS operations and testing. It is necessary to determine a ship type before comparing the CSARB requirements for MCCS testing.

Comments:

- The MCCS Controls and Operation Test Procedure should be customized to a particular ship type and contract.
- The MCCS Controls and Operation Test Procedure should address testing requirements for pier side trials and Sea Trials.
- Some shipyards benchmarked consider the MCCS Controls and Operation Test Procedure part of MCCS Dock Trials. Others use both this test memo and a Dock Trials memo to verify all operations.

Recommendation:

The MCCS Controls and Operation Test Procedure will consolidate all operational requirements of the MCCS system. Depending on the requirements, this procedure could be a separate test procedure, or it could be considered part of the Dock Trials. A ship with a simple machinery plant could combine The MCCS Controls and Operations and the Dock Trial test procedures. However, a more complicated plant would require a demonstration of a majority of the operations before the Dock Trial.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Electric Motor Operated Valves

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
	There is no specific requirement for testing electric motor operated valves; however, the generic testing statements require operations of all electrical equipment. Descriptions below are modified interpretations.
46CFR 91.25-25	Requires testing remote control operations on all valves dealing with the hull.
ABS 4/5/21.1	All auxiliary apparatus is to tried under working conditions.
IEEE 46.1, 46.2.4	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/56)	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
LLOYD 6/2/20.2.4	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
DNV 4/4/9/E101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- Testing of motor operated valves should commence after flushes and hydrostatic testing are completed for a particular system.
- Remote control operations of valves should also be tested at this time.

Recommendation:

A test procedure is required to verify operations of all electric motor operated valves. The test procedure may start as soon as the production work on an individual system has been completed. The test procedure should include electric motor operated valve operations, light indications, motor readings, etc.

Test Procedure Title: Navigation and Signal Lights

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 111.75-17	46CFR requirements reference USCG Navigation Rules , International -Inland COMDTINST M16672.2A. The inspections required include verifying locations, colors and total arc visibility, and operational checks of navigation panel and all associated lights.
ABS 4/5/21.1	All auxiliary apparatus is to be tried under working conditions.
IEEE45-46.2.5	Operational verification shall be performed.
JIS 8069-86(IEC 92-306); JIS 8072-86 (IEC 401/11/63)	JIS refers to the International Convention on Regulations for Preventing Collisions at Sea (COLREGS). Operational verification shall be performed.
LLOYD 6/2/14.5, 6/2/20.2	After installation is complete, and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
DNV 4/8/3/A500	DNV requires compliance to statutory requirements of the register country. Reference requirements of International Convention on Regulations for Preventing Collisions at sea (COLREGS).

Comments:

- All shipyards benchmarked have an operational verification test procedure for the navigation and signal lights.
- Generally, U.S. shipyards include location and lens color verification. This verification was not included in test procedures reviewed from foreign shipyards.

Recommendation:

A test procedure for navigation and signal lights is required, and shall show operation of lights and panel as necessary. However, location verification should be an in-process procedure completed during construction.

Test Procedure Title: Integrated Bridge Electronic Systems

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21.1 JIS 8072-86(IEC 92-401/11/55,65) LLOYD 6/2/20.2, 7/9/6.1 DNV 4/4/9/E100, 6/8/10-All	The ABS rules and 46CFR do not have any direct requirements that address testing of an “integrated bridge system” but are developing a common definition of an “integrated bridge system”. Lloyd’s rules and DNV rules do directly address this type of system and its requirements. However, the specific requirements for this test procedure are particular to each class of ship. Therefore a comparison of CSARB requirements can only be made after equipment type has been determined.

Comments:

- The test procedure for the integrated bridge system should be customized to suit a particular ship classification and contract. The test procedure shall include testing of several individual components that have been combined into a single set of consoles.
- The following equipment may be installed as part of an integrated bridge system:
  Autopilot, GPS, radar system, gyro system, magnetic compass, echo sounder, doppler speed log, anemometer and anemoscope, voyage event recorder and misc. metering.

Recommendation:

The integrated bridge electronic system requires a test procedure customized for a particular ship type or contract. Generally, the vendor who manufactures and installs the equipment will also be tasked with testing, Therefore, it may be best for the vendor to develop the test procedure.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Interior Communications Insulation Resistance Tests

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 111.60-21	References the requirements of IEEE45, section 46.2.1.
ABS 4/5/B3.3	Stated requirements are for power and lighting circuit insulation resistance readings. Reference chart for minimum resistance readings between conductors, and between conductors and ground.
IEEE45-46.2.1	Stated requirements for power and lighting circuit insulation resistance readings. Reference chart provides minimum resistance readings between conductors, and between conductors and ground. Part 2 on interior communication states for each circuit of 115v and above, insulation resistance should be at least 1 meg ohm, and for circuits below 115v, insulation resistance should be above 1/3 meg ohm.
LLOYD 6/2/20.2.2	Stated requirements are for all electrical circuits to have insulation resistance readings. Reference chart shows readings between conductors, and between conductors and ground, to be a minimum of 1 meg ohm.
JIS 8072-86 (IEC 92-401/7/65,66)	Each circuit operating at a voltage of 55 v and above shall have an insulation resistance reading of greater then one meg ohm. Circuits below 55 v shall have an insulation resistance reading of greater than 1/3 meg ohm.
DNV 4/4/9/E303	Insulation resistance is applied to every outgoing circuit, with a minimum attainable value of 1 meg ohm. This applies to instrumentation and communication circuits with voltages above 30 volts ac and above 50 volts dc.

Comments:

- The U.S. shipyards benchmarked are only required to take insulation resistance readings on circuits that are 115 v and above for power, lighting, and interior communications.
- Interior communications circuits of less then 115 v are recommended by IEEE to be verified.
- The foreign shipyards benchmarked are required to take readings of all circuits.

Recommendation:

A separate test procedure is not required, provided an in-process procedure is in place. The readings recorded on the check sheets would satisfy the need for documentation.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Dial Telephone System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5/21.2	Requires demonstration to Surveyor's satisfaction.
IEEE45 46.2.7	Demonstrate system to determine suitable and specified functions.
JIS 8072-86(IEC 92-401/11/65)	Demonstrate system to determine suitable and specified functions.
LLOYD 6/2/20.2.4, 20.2.6	All essential and other important equipment is to be operated under service conditions. Demonstrate, by practical tests, that the Rules have been complied with.
DNV 4/4/9/E401	All essential and other important equipment are to be operated under service conditions.

Comments:

- Pre-checks of circuits not required, only operational tests.
- Test the Dial Telephone System when the system can be tested as a whole.

Recommendation:

The Dial Telephone System Test Procedure shall address operational testing of the completed system.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Sound Powered Telephones

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5/21.2	Requires demonstration to Surveyor's satisfaction.
IEEE45 46.2.7	Demonstrate system to determine suitable and specified functions.
JIS 8072-86(IEC 92-401/11/65)	Demonstrate system to determine suitable and specified functions.
LLOYD 6/2/20.2.4, 20.2.6	All essential and other important equipment is to be operated under service conditions. Demonstrate, by practical tests, that the Rules have been complied with.
DNV 4/4/9/E401	All essential and other important equipment are to be operated under service conditions.

Comments:

- Pre-checks of circuits not required, only operational tests.
- Test Sound Powered Telephone System when the system can be tested as a whole.

Recommendation:

The Sound Powered Telephone System Test Procedure shall address operational testing of the completed system.

Test Procedure Title: General Alarm and Announcing System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 113.25-9 through 12	The 46CFR outlines standard operational requirements. Additionally, the 46CFR contains a requirement to have a minimum dB level above operating conditions at sea to be demonstrated during Sea Trials.
ABS 4/5/21.1	Requires demonstration to Surveyor's satisfaction.
IEEE45 46.2.7	Demonstrate system to determine suitable and specified functions.
JIS 8072-86(IEC 92-401/11/65)	Demonstrate system to determine suitable and specified functions.
LLOYD 6/2/20.2.4, 20.2.6, 20.2.7	All essential and other important equipment are to be operated under service conditions. Demonstrate, by practical tests, that the Rules have been complied with.
DNV 4/4/9/E401	All essential and other important equipment are to be operated under service conditions.

Comments:

- A test procedure should address operational checks of contactors, bells, and lights, before Dock Trials/Sea Trials.
- Operational checks of general alarms are to be performed.
- There is also a requirement by 46CFR 113.25-12 to have a minimum dB level above operating conditions at sea. This would be verified during Sea Trials.

Recommendation:

The General Alarm and Announcing System Test Procedure shall address operational checks for pre-trials. The minimum dB level checks should be incorporated into the Sea Trials Test Procedure.

Test Procedure Title: Entertainment System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5/21.1	Requires demonstration to Surveyor's satisfaction.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/56)	
LLOYD 6/2/20.2	
DNV 4/4/9/E101	

Comments:

- There are no specific requirements for entertainment system testing. The generic testing statement of operational checks to the satisfaction of the Surveyor applies.

Recommendation:

The Entertainment System Test Procedure should address operational testing of the subject equipment.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Gas Detection System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21 JIS 8072-86(IEC 92-401) LLOYD 6/2/20.2 DNV 4/4/9/100	There are no specific CSARB requirements for testing of gas detection systems. The generic statement regarding operational checks to the satisfaction of the Surveyor applies.

Comments:

- There is no specific CSARB requirements.
- Onboard testing of the completed system is most applicable.

Recommendation:

The Gas Detection System Test Procedure shall address onboard operational testing of the system.

Test Procedure Title: Fire Detection System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 176.810	USCG requires testing of all smoke and fire detection systems, including sensors and alarms, for initial inspection of certification.
ABS 4/5.21 ABS 4/11.1.5	Requires demonstration to Surveyor's satisfaction. Remote control and monitoring systems are to be subjected to tests witnessed by the Surveyor.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/65)	Demonstrate system to determine suitable and specified functions.
LLOYD 6/2/20.2.6	Demonstrate, by practical tests, that the Rules have been complied with.
DNV 4/4/9/E101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested. (SOLAS requirements are referenced extensively; however, there are no specific testing requirements).
ASTM F 1198	Functional tests should be performed on all components of the fire detection system for system commissioning.

Comments:

- Prove operational abilities of ship's fire/smoke detection systems.
- May be included as part of the unmanned engine room requirements for ACCU demonstrations.
- Perform fire detection system testing before Sea Trials.

Recommendation:

The Fire Detection System Test Procedure shall address onboard operational testing of the system.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Miscellaneous Alarms and Warning Systems

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Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21	Requires demonstration to Surveyor's satisfaction.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/56)	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
LLOYD 6/2/20.2.6	Demonstrate, by practical tests, that the Rules have been complied with......
DNV 4/4/9/E/101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- There are no specific requirements for testing. The generic testing statement regarding operational checks to the satisfaction of the Surveyor applies.
- The Miscellaneous Alarm and Warning Systems Test Procedure is a generic test memo which addresses small electrical systems.
- The subject systems vary based on ship type, such as refrigeration alarms, medical alarms, anemometer and anemoscope system, etc.
- All shipyards benchmarked had a test procedure that addressed miscellaneous electrical systems.

Recommendation:

The Miscellaneous Alarm and Warning Systems Test Procedure should address small electrical systems which do not warrant a separate test procedure.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Radio Communication Equipment

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21.1	Requires demonstration to survey's satisfaction. There is no reference to exterior communication.
JIS 8072-86(IEC 92-401/11/68)	Equipment installed to implement the international conventions in force shall be specially tested to ensure that all requirements have been met.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
LLOYD 6/2/20.6	Demonstrate, by practical tests, that the Rules have been complied with.
DNV 4/9 SOLAS/chap. 4	Requirements vary depending on area of operation.
DNV 4/4/9/E/101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- There is no direct shipboard testing requirements within the CSARB documentation.
- There is, however, extensive performance requirements throughout the CSARB documentation.
- Requirements are dependent on the operational area of the world. The type of equipment required by a ship, and the method in which that equipment is tested, is based on the intended operational zone.
- Equipment and operator are required to be certified by FCC rules in the U.S.
- Normally, the equipment vendor has their own test requirements or procedures.
- All shipyards benchmarked maintained a test procedure for radio communications equipment.

Recommendation:

The Radio Communications Test Procedure shall be developed by the subject equipment vendor, addressing final operational testing at sea.

Test Procedure Title: Ship's Whistles

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
33CFR 86	Requires dB level measurements for maximum output verification.
ABS 4/5.21	Requires demonstration to survey's satisfaction.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/68)	Equipment installed to implement the international conventions in force shall be specially tested to ensure that all requirements have been met.
LLOYD 6/2/20.2.6	Demonstrate, by practical tests, that the Rules have been complied with.
DNV 4/4/9/E/101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- There are no specific requirements for testing. The generic testing statement regarding operational checks to the satisfaction of the Surveyor applies.
- All shipyards benchmarked have operational test procedures for the ship's whistle.

Recommendation:

The Ship's Whistle Test Procedure shall address operational testing.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Shipboard Personal Computer Network

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21	Requires demonstration to the satisfaction of the Surveyor.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/56)	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
LLOYD 6/2/20.2.4	All essential and other important equipment are to be operated under service conditions.
DNV 4/4/9/E/101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- There are no specific requirements for testing. The generic testing statement regarding operational checks to the satisfaction of the Surveyor applies.
- The test of the PC network is generally a ship specific requirement.

Recommendation:

The PC Network Test Procedure shall be developed by the subject equipment vendor to address operational testing.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: MCCS Periodic Test

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
46CFR 61.40, 62 ABS 4/11.1.5 JIS 8076-86 (IEC 92-504) LLOYD 6/1/7 DNV 4/5	There is a large amount of information concerning MCCS design and testing. It is not practical to summarize the requirements of the individual CSARB. Each CSARB has complete sections addressing MCCS operations and testing. It is necessary to determine a ship type before comparing the CSARB requirements for MCCS testing.

Comments:

- It is a requirement to have annual/biannual checks.
- The MCCS Periodic Test should be customized to a particular ship type and contract.

Recommendation:

The MCCS Periodic Test consolidates all operational requirements of the MCCS system and should be written to address specific ship types or classes.

Test Procedure Title: UHF Internal Communication Systems

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21	Requires demonstration to the satisfaction of the Surveyor.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/56)	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
LLOYD 6/2/20.2.6	Demonstrate, by practical tests, that the Rules have been complied with.
DNV 4/4/9/E/101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- There are no specific requirements for testing. The generic testing statement regarding operational checks to the satisfaction of the Surveyor applies.

Recommendation:

The UHF Internal Communication Systems Test Procedure should address the vendor specific equipment installed onboard.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Closed Circuit Television System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21	Requires demonstration to Surveyor's satisfaction.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/56)	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
LLOYD 6/2/20.2.4	All essential and other important equipment are to be operated under service conditions.
DNV 4/4/9/E/101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- There are no specific requirements for testing. The generic testing statement regarding operational checks to the satisfaction of the Surveyor applies.

Recommendation:

The Closed Circuit Television System Test Procedure should address the vendor specific equipment installed onboard.

Test Procedure Title: Tank Level Indicators

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21	Requires demonstration to Surveyor's satisfaction.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/56)	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
LLOYD 6/2/20.2.4	All essential and other important equipment are to be operated under service conditions.
DNV 4/4/9/E/101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- There are no specific requirements for testing. The generic testing statement regarding operational checks to the satisfaction of the Surveyor applies.
- All shipyards benchmarked perform calibration checks and operational verifications on tank level indicators.
- Verification of readings often must be accomplished at sea because of pierside restrictions.

Recommendation:

The Tank Level Indicator Test Procedure should address both the operation and calibration of tank level indicators as well as the level verifications.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Piping Systems Hydrostatic Testing

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/6.7	All piping systems are to be pressure tested to 1.5 times the design pressure. Fuel oil service lines are to be tested to a minimum of 3.4 bar or 1.5 times the design pressure, whichever is greater. Exceptions are fuel oil suction and transfer lines which are to be tested to 3.4 bar and pipes attached to the boiler which, if they are impractical to isolate; are to be subjected to the same hydrostatic pressure as the boilers are after installation.
DNV 4/1-41	Before installation on board and before lagging and coating, all class 1 &2 piping and fittings are to be subjected to hydrostatic tests in the Surveyor's presence to 1.5 times the design pressure. Steel pipes with design temps above 300 C, test pressures are slightly higher in accordance with given formulas. After installation on board, all pipes hydrostatically tested at a maximum pressure of 1.5 times the design pressure and minimum pressure of 4 bar. The same is required for hydraulics except that the test pressure need not exceed the working pressure by more than 70 bar. Plastic pipes have a minimum pressure of 6 bar and duration of 1 hour.
LR 5/12.7	For design temperatures below 300 C, all class 1 and 2 pipes and their associated fittings are to be tested by hydraulic pressure to 1.5 times the system design pressure. Higher test pressures are realized for steel pipe and systems above 300°C. After assembly on board, tank heating coils and fuel oil piping are to be tested to 1.5 times the design pressure or 3.5 bar, whichever is greater.
46 CFR 56.97-30	Every point in a piping system must be subjected to a hydrostatic test pressure of 1.5 times the design pressure for a minimum of 10 minutes, as long the stress doesn't exceed 90% yield strength. Class 2 piping systems shall be tested under working conditions on initial service leak test. Where hydrostatic testing is not practical, an initial service leak test and inspection is acceptable.

Comments:

- During the production process, all piping systems must be hydrostatically or pneumatically tested to show system tightness.
- The CSARB's are all fairly consistent with regard to hydrostatic testing requirements of various piping systems.
- The CSARB's allow partial systems testing as long as every point in a system is tested after installations to the required pressure.
- The hydrostatic tests of the piping is a prerequisite to system testing.
- Some foreign shipyards address hydrostatic testing of piping systems as an in process inspection, while other foreign and domestic yards have a piping hydrostatic test procedure.

Recommendation:

The hydrostatic testing requirements for piping systems should be a test procedure, allowing the tests to be performed at all stages of the construction process.

Test Procedure Title: Mechanical Instruments Calibration

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 1/1-9	Measuring and test equipment used in services is to have a calibration status or an appropriate accuracy to the Surveyor's satisfaction.

Comments:

- There are no test requirements for the calibration of pressure gauges, thermometers, and other mechanical instruments.
- Good shipbuilding practices require the calibration of mechanical instruments.
- Other shipyards benchmarked, both foreign and domestic, do not have a test procedure for the calibration of mechanical instruments.

Recommendation:

We recommend that the calibration of mechanical instruments should be confirmed as an in process inspection.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Ventilation Fans and Controls

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21.1	Electrically, all auxiliary apparatus is to be tried under working conditions. The operation of lighting systems, heaters, etc., is to be demonstrated satisfactorily.
DNV 4/4-55	Before a completed installation is put into service, the electrical equipment is to be tested to the Surveyor's satisfaction.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the ventilation fans and controllers in a test procedure.

Recommendation:

The test procedure for the ventilation fans and their controls should address pre-trials testing of the system operating under normal working conditions.

Test Procedure Title: Fire Dampers

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
LR 20.2.6	It is to be demonstrated by practical tests that the rules have been complied with in respect of fire emergency and ship safety systems.
JIS 2422	Tests include fire damper visual inspections, operational test of movable parts, a thermal fuse test to 1.25 time the nominal operating temperature, and a leak test, performed 3 times at 2kPa to both surfaces of the movable vane.
SOLAS II-2 Reg 16	Fire dampers shall operate automatically but shall also be capable of being closed manually from both sides of the bulkhead or deck.
ASTM F 1198	While operating the fire detection alarm system, verify proper operation of automatically operated doors and dampers.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- The fire damper testing should be performed with other ventilation test procedures.
- Other shipyards benchmarked, both foreign and domestic, test the fire dampers in a test procedure.

Recommendation:

A separate test procedure is not required. The testing of the fire dampers should be included in the ventilation test procedure. The testing should be performed pre-trials under normal operating conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Ventilation Systems Balance

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
	For cargo pump-rooms, the number of air changes shall be at least 20 per hour. No specific test items for the balancing of ventilation systems could be found.

Comments:

- There are no test requirements for the balancing of the ventilation systems.
- Good shipbuilding practices require that the ventilation within each space be balanced based on the air changes per hour according to the design specifications.
- The balancing of the systems should be late in the shipbuilding cycle as all accommodations spaces should be complete prior to this test.
- Other yards benchmarked, both foreign and domestic, have a separate ventilation balancing test procedure.

Recommendation:

There are no CSARB requirements for the balancing of ventilation systems and a test procedure is not required. The necessary system balancing accomplished prior to Sea Trials can be done as an in-process inspection.

Test Procedure Title: Accommodation Heating Equipment

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/4-55	Before a completed installation is put into service, the electrical equipment is to be tested to the Surveyor's satisfaction.
ABS 4/5.21.1	The operation of heaters is to be demonstrated satisfactorily.
CFR 111.87	When testing for maximum temperature of the heater casing, an ambient temperature of 25°C must be used.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.
IEEE 1983 32.2	The external temperature of the heater casings should not exceed 125°C; the flush type, not to exceed 100°C. The nearest deck or bulkhead surface will not exceed a temperature of 55°C. The heater, when hot, should withstand a 500 volts ac, 60 Hz, for 1 minute applied between the frame and the current carrying parts. An ambient temperature of 25°C should be used when testing.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the accommodation heating equipment in a test procedure.

Recommendation:

A test procedure for the accommodations heating equipment should address pre-trials testing of the system operating under normal working conditions.

Test Procedure Title: Accommodation Air Conditioning Test

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**

Comments:

- There are no requirements for the testing of the accommodation air conditioning system.
- Good shipbuilding practices require that the air conditioning to each obligated space be adequate for the intended purpose.
- The air conditioning test should be combined with the A/C plant operation test and the accommodation heating equipment test.
- Other shipyards benchmarked, both foreign and domestic, test the accommodation air conditioning in a test procedure.

Recommendation:

Although there is no specific A/C accommodations tests required, a test procedure should be written to prove the ventilation installations and A/C cooling capabilities.

Test Procedure Title: Air Conditioning Plants

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
CFR 58.20-25	After installation, all pressure vessels, compressors, piping, & direct expansion cooling coils shall be leak tested to the design pressures.
ABS 4/12.47	After installation, primary refrigerant systems are to be leak tested at the working pressure with a suitable gas. Secondary systems are to be tested to twice the working pressure or 8.6 bar, whichever is greater. Upon completion, the machinery is to be tested under working conditions.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the A/C plants in a test procedure.

Recommendation:

The test procedure for the A/C plants should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Ship Stores Refrigeration Plants

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
CFR 58.20-25	All pressure vessels, compressors, piping, and cooling coils shall be hydrostatically or pneumatically tested to their design pressures after installation.
LR 6/3.5	Pneumatic pressure test for primary piping, at 1.5p and using an inert gas, to test the welds. After completion, a leak pressure test with an inert gas at design pressure in presence of Surveyor.
DNV 5/10-21	A hydraulic strength test and a pneumatic tightness test of the components are to be carried out in the presence of a Surveyor. Multiple operational and overall performance tests are to be performed after shipboard installation.
ABS 4/12.45,47	After installation, leak tests, secondary refrigerant system tests, and an overall machinery and insulation test are to be performed under working conditions.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the ships stores refrigeration plants in a test procedure.

Recommendation:

The test procedure for the ships stores refrigeration plants should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Auxiliary Boiler Services

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
LR 5/10.17 5/1.5.1.1	Boilers are to withstand hydraulic tests, either as a full system, or in parts and then in full, depending on the boilers' design. All boiler mountings are to be subjected to a hydraulic test. Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.
ABS 4/6.7.2 4/6.7.8	Boiler-feed piping is to be tested, preferably before installation, to 1.5 times the design pressure. Pipe joints welded on the ship are also tested to 1.5 times the design pressure. After installation, all piping is to be tested under working conditions.
DNV 4/3-46	On completion, boilers are to be tested to 1.5 times the calculating pressure or, each component can be tested to 1.5 times and the completed unit can be tested to 1.25 times the calculating pressure. Boiler feed check & stop valves are to be tested to 2.5 times the calculating pressure or twice the maximum pressure that can be developed under normal service, whichever is greater. After on-board installation, boilers are to be function tested, including instrumentation, automation, and remote control systems.
CFR 52.01-135 61.10, 61.35, 58.01-30, 61.05-05	After installation, each boiler is to be hydrostatically tested to 1.5 times the maximum allowable working pressure. The water used for hydrostatic tests must be between a 70°F to 160°F for watertube boilers and between 70°F to 100°F for firetube boilers. Before boiler insulation, accessible parts shall be emptied, opened up, & all interior faces shall be examined for defects from hydrostatic testing. After installation on board, operations and checks of all safety, controls, alarms, and relief valves are to be performed in the presence of a marine inspector. Boiler operations are observed at Sea Trials for safety deficiencies.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the ships auxiliary boilers and services in a test procedure.

Recommendation:

The test procedure for the ships auxiliary boilers and service system should address pre-trials testing of the system operating under normal working conditions.

Test Procedure Title: Drain and Vent Piping

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/6.7.8	All piping is to be tested under working conditions after installation.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and system tightness.
- The tank vents should be tested in conjunction with the tanks' air and hydrostatic test procedures.
- The drainage piping should be combined with the pipe hydrostatic test procedure.
- Other shipyards benchmarked, both foreign and domestic, do not test the drain and vent piping separately in a test procedure.
- Often the vent tests are combined with the tank tests, and the drainage tests are combined with the piping hydrostatic tests.

Recommendation:

A separate test procedure is not required. The drain and vent piping test procedure should be combined with the tank pressure tests and the piping systems hydrostatic tests.

Test Procedure Title: Machinery Bilge and Oily Waste Transfer System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
LR 3/1.8.3.8	Bilge suction in holds to be tested under working conditions.
DNV 4/1-42	All piping systems are to be properly flushed, checked for leakage, and functionally tested under working conditions to the Surveyors satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the machinery bilge and oily waste transfer system in a test procedure.

Recommendation:

The test procedure for the machinery bilge and oily waste transfer system should address pre-trials testing of the system operating under normal working conditions.

Test Procedure Title: Distilling Plant

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 0801-89	Distilling plant capacity test shall be carried out at Sea Trials if necessary.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.

Comments:

- Prior to Sea Trials, demonstrate proper system tightness and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, did not have the testing of the distilling plant in a test procedure.

Recommendation:

Test procedure not required, capacity test to be accomplished during Sea Trials.

Test Procedure Title: Potable Water System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
LR	For a water tanker, quality of water shall comply with directive 80/778/EEC of the European union. Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.

Comments:

- Prior to Sea Trials, demonstrate proper system tightness and operations, including all controls and safety devices.
- Verify service at distant points in the system.
- Other shipyards benchmarked, both foreign and domestic, test the potable water system in a test procedure.

Recommendation:

The test procedure for the potable water system should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Fuel Oil Fill, Transfer, and Purification Systems

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Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 6602-79	All centrifugal oil purification tests can be done as a shop test.
ABS 4/6.7.4 4/6.7.8	Transfer systems and fuel-oil suction lines are to be tested after installation to 3.4 bar. All piping is to be tested under working conditions after installation.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the fuel oil fill and transfer system in a test procedure.

Recommendation:

The test procedure for the fuel oil fill and transfer system should address pre-trials testing of the system operating under normal working conditions.

Test Procedure Title: Compressed Air Distribution Systems System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/6.7.8	All piping is to be tested under working conditions after installation.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations.
- Verify service at distant points in the system.
- Other shipyards benchmarked, both foreign and domestic, test the compressed air distribution systems in a test procedure.

Recommendation:

The test procedure for the compressed air distribution system should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: CO_2 Fire Extinguishing Systems

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/6-10	On completion, the CO_2 system is to be function tested according to an approved test program.
NVIC 6-72	Hydrostatic tests of the pipes is suggested, as are the remote control operations for CO_2 release and the discharge delays, alarms, and switches. Cylinders should be weighed and recharged if loss exceeds 10%. Prove remote controls, auto vent shutdown, and pre-discharge alarm operations.
CFR 91.25-20	Weigh cylinders and recharge if weight loss exceeds 10% of weight of charge. Inspect hose and nozzle to ensure they are clear. On all fire-extinguishing systems, all piping controls, valves, and alarms shall be checked to ascertain that the system is in operating condition.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Cylinders are to be weighed and recharged if weight loss exceeds 10% of normal charged weight.
- Other shipyards benchmarked, both foreign and domestic, test the CO_2 systems in a test procedure.

Recommendation:

The test procedure for the CO2 system should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Firemain and Foam System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
NVIC 6-72	Verify adequacy of pump capacity by measuring pressure at the 2 highest 2 1/2 inch outlets. Pressure should not be less than 75 psi for tank vessels. Visual inspection of the whole system arrangement & layout, including connections, relief valves, and system segregation. Recommended foam system check is to operate the fire pump to insure required flow rates for 15 minutes. It should be determined that the foam system operations does not interfere with simultaneous use of firemain system.
ABS 4/9.7.2 4/6.7.8	For two fire pumps simultaneously delivering water, the minimum pressure to be maintained at all hydrants is 40 psi. All piping is to be tested under working conditions after installation.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.
CFR 95.10-5, 76.23-15, 91.25-20	Each fire pump shall be capable of delivering water simultaneously from the two highest outlets at an approximate pitot tube pressure of 50 psi. Relief valves on the discharge side of the fire pump shall be set at 25 psi in excess of the pressure necessary to maintain 50 psi at the two highest outlets, or at 125 psi, whichever is greater. If firepumps are used for the sprinkling system, satisfactory conditions are met when a pitot tube reading at all heads of at least 15 psi in the largest sprinkling system zone and a simultaneous pitot tube reading of approximately 50 psi at the two highest fire hose outlets is realized. The firemain system shall be operated and the pressure checked at the most remote and highest outlets. On all fire-extinguishing systems, all piping controls, valves, and alarms shall be checked to ascertain that the system is in operating condition.
SOLAS II-2A Reg 4, Reg 9	Each fire pump shall have a capacity not less than 80% of the total required capacity divided by the minimum number of required pumps and must not have a flow rate less than 92 gpm. With two pumps simultaneously delivering water, the diameter of the fire main piping needs to be sufficient enough to deliver 616 gpm and the minimum pressure at all hydrants is to be 39.2 psi. For high expansion foam, foam shall be sufficient to cover 3.3 feet in depth per minute.

Comments:

SYSTEM TESTING AND INSPECTION REQUIREMENTS

- Prior to Sea Trials, demonstrate proper system installation and operations for both the firemain system and the foam system, including all controls and safety devices.
- Verify required service pressures at distant points in the system.
- At trials, operational test of the foam system for each covered zone.
- Other shipyards benchmarked, both foreign and domestic, test the firemain and foam systems in a test procedure.

Recommendation:

The test procedure for the firemain and foam systems should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: APC Fire Extinguishing Systems (Galley Hoods)

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/6.7.8	All piping is to be tested under working conditions after installation.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.
NVIC 6-70	The fixed fire extinguishing system for galley hoods must be on the approved listing by the Underwriter's lab. The installation must be in accordance with the laboratories listing and labeling requirements and the manufacturer's recommended procedures.
CFR 91.25-20	On all fire-extinguishing systems, all piping controls, valves, and alarms shall be checked to ascertain the system is in operating condition.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, do not have the testing of the APC fire extinguishing system in a test procedure.
- APC fire extinguishing system testing may be combined with other fire extinguishing tests.

Recommendation:

Testing of the APC fire extinguishing systems does not require a separate test procedure, and should be combined with the fire extinguishing test procedure, addressing pre-trials testing under normal working conditions.

Test Procedure Title: Steering Gear System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 3.3-24	After on board installation, the steering gear is to perform the required hydrostatic and running tests. Also, it is to be tried out on the trials for demonstration to the Surveyors satisfaction.
ABS 4/8.9.5g 4/8.13	After fabrication, each piping component is to be hydrostatically tested in the shop to 1.5 times the relief valve setting, 2 times if gear cylinders are of nodular iron. After installation, the whole system is to be subjected to a hydrostatic test to 1.1 times the relief valve setting. The steering gear is to be tried on Sea Trials in order to show, to the Surveyors satisfaction, compliance with the rule requirements.
JIS 0809-91	Operational tests are to be carried out at sea.
LR 5/19.7	Hydro and running test prior to trials and operation at trials.
CFR 58.25-20, 58.30-35, 58.01-30	Piping systems shall be hydrostatically tested in the presence of the Marine Inspector at 1.5 times the maximum allowable pressure. The operation of the steering gear shall be observed on the trial trip of each new vessel and all deficiencies which affect the safety of the vessel shall be corrected to the satisfaction of the Officer in Charge.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations for the steering gear system, including all controls and safety devices.
- At trials, operational tests on the steering gear is required.
- Other shipyards benchmarked, both foreign and domestic, test the steering gear in a test procedure.

Recommendation:

The test procedure for the steering gear system should address pre-trials testing of the system operating under normal working conditions. Additionally, the steering gear is tested during Dock Trials and Sea Trials.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Marine Sanitation Device System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
33 CFR 159.101	Testing of MSD's must be accomplished at a recognized facility, unless otherwise authorized by the Coast Guard. The device must be set up in a manner simulating installation and conditions on a vessel. Tests include vibrational, shock, rolling, pressure, temperature, chemical resistance, and sewage process tests.
DNV 4/1-42	All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.8	After installation, all piping is to be tested under working conditions.
LR 5/1.5.1.1	Tests of components and trials of machinery for individual systems are to be carried out to the satisfaction of the Surveyor.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the marine sanitation device system in a test procedure.

Recommendation:

The test procedure for the marine sanitation device should address pre-trials and trials testing of the system operating under normal working conditions.

Test Procedure Title: Stores Handling Cranes

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 6/1-7	After installation on board, functional testing of the crane is to be carried out in accordance with the “Rules for Certification of Lifting Appliances”.
ABS Guide for Certification of Cranes	Proof load testing at various boom situations, operation of all brakes and fail-safe devices, and examination for the damage of parts after test.

Comments:

- Prior to Sea Trials, demonstrate proper installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the stores handling crane in a test procedure.

Recommendation:

The test procedure for the stores handling crane should address pre-trials and trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Incinerator

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS F 7011-89	Operating tests of safety and alarm devices as well of operation test of the incinerator is to be done shipboard.
ASTM F 1323.8	Operational test after installation to ensure all components are properly installed and are operating satisfactorily.
DNV 4/3-47	A newly designed incinerator are to fulfill an approved test program before installation. After on-board installation, incinerators are to undergo a test run in the presence of the Surveyor.
MEPC.59 33/20/add.1	After on-board installations, conduct flame safeguard operations, various controls, low voltage test for fuel supply shutoff, and all switches.
ASTM F 1323 8.3	An operating test after installation shall be conducted to ensure that all of the control components have been properly installed and that all parts of the incinerator, including controls and safety devices, are in satisfactory operating conditions.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the incinerator in a test procedure.

Recommendation:

The test procedure for the incinerator should address pre-trials testing of the system under normal working conditions.

Test Procedure Title: Inert Gas System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 1/3.24	Annual survey is required, which includes visual inspections and operational and controls tests of the system.
LR 5/15.7.8	The system, including alarms/safety devices, is to be installed on-board and tested under working conditions to the satisfaction of the Surveyor.
DNV 5/3-33	After completion, the inert gas installation is to be surveyed by the Surveyor. Alarm, function, and capacity tests are to be performed under normal operating conditions.
SOLAS II-2 Reg 62	The inert gas system shall be designed, constructed, and tested to the satisfaction of the Administration. Also covered are system design requirements for proper installation and operations.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked varied on whether or not the inert gas system was tested in a test procedure.

Recommendation:

The test procedure for the inert gas system should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Cargo Oil System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 5/3-13, 4/1-42	Cargo oil piping is to be tested to 1.5 times the system design pressure. If hydrostatic tests of separate pipe pieces was completed prior to installation on-board, a tightness test of the system to the design pressure is to be accomplished after installation is complete. All piping systems are to be properly flushed and functionally tested under working conditions to the Surveyor's satisfaction.
ABS 4/6.7.6 4/6.7.8	After installation, cargo-oil piping systems are to be tested to 1.5 times the system design pressure. All piping is to be tested under working conditions.
LR 5/12.7.1 5/1.5.1.1	Class 1 & 2 pipes and fittings are to be hydraulically tested to 1.5 times the design pressure to the satisfaction of the Surveyor as are tests of components and trials of machinery for individual systems.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked varied on whether or not the cargo oil piping system was tested in a test procedure

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Recommendation:

The test procedure for the cargo oil piping system should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Fixed Tank Cleaning System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/6.71.14 4/6.7.6 4/6.7.8	Installations and testing of the tank cleaning system is to be in accordance with cargo piping systems, which require piping to be tested to 1.5 times the design pressure after on-board installation. After installation, all piping systems are to be tested under working conditions.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked varied on whether or not the fixed tank cleaning system was tested in a test procedure.

Recommendation:

The test procedure for fixed tank cleaning system should address pre-trials testing of the system operating under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Hydraulically Operated Valves

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/1- 41, 42	After installation, class 1 &2 fittings are to be hydrostatically tested to 1.5 time the design pressure. All piping systems are to be properly flushed, checked for leakage, & functionally tested under working conditions to the Surveyors satisfaction.
CFR 91.25-25	The remote controls of all valves shall be operated at each inspection for certification.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices. Other yards, both foreign and domestic, test the HOV's in a test procedure.

Recommendation:

Test procedure for HOV's should be written to cover pre-trials testing of the system under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Engine Room Bridge Crane

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 0802-89	Structural deflection tests and hoist operational tests are to be performed after on-board installations.
LR 6.1-7	After installation on-board, functional testing is to be carried out in accordance with the "Rules for Certification of Lifting Appliances".
ABS 4/1.11.1 ABS Certification of Construction and Survey of Cargo Gear on Merchant Vessels, Sec. 3.3.1, 3.3.4	Before the cargo gear is placed in service, it is to be tested as an entire unit on the vessel to listed criteria. After being tested, all cargo gear is to be examined to see whether any part has been injured or permanently deformed by any test. On all types of winches, efficient means to stop and hold the load in any position are to be demonstrated.

Comments:

- Prior to Sea Trials, demonstrate proper installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the engine room bridge crane in a test procedure.

Recommendation:

The test procedure for the engine room bridge crane should address pre-trials testing of the subject equipment under normal working conditions.

Test Procedure Title: Misc. Padeyes, Monorails, and Jacob's Ladders

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 3410-90 0802-89	A visual inspection of padeyes is required to check for weld discrepancies and to prevent sharp material edges. For monorails, the deflection of the center of the girder shall be measured at the rated load and at 125% load.

Comments:

- After installation, perform a visual inspection of the padeyes.
- Prior to Sea Trials, the deflection of the monorails should be measured.
- Neither the foreign nor the domestic shipyards benchmarked test the handling padeyes or the deflection of the monorails in a test procedure.
- The visual inspection of the padeyes should be combined with the inspection of the padeyes inside the machinery space.

Recommendation:

For handling padeyes, we recommend performing a visual inspection. For the deflection of the monorail, we propose to test it as part of a crane test procedure.

Test Procedure Title: Mooring Winches

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 3/3-38	Only has design guidance-no specific testing requirements.
JIS 6709-95	Type and individual testing of mooring winch after assembly completion in the shop. Cargo winch must be tested after installation on-board with at least one hoisting and lowering of the test load, not to exceed 1.25 times the drum load. Performance criteria of winch and wire rope is to be verified by means of a shop test, but only if type test hasn't been performed.
LR 3/13.7	A final underway trial is to be made of all ground tackle.
ABS 4/1.11.1 ABS Certification of Construction and Survey of Cargo Gear on Merchant Vessels, Sec. 3.3.1, 3.3.4	Before the cargo gear is placed in service, it is to be tested as an entire unit on the vessel to listed criteria. After being tested, all cargo gear is to be examined to see whether any part has been injured or permanently deformed by the test. On all types of winches, efficient means to stop and hold the load in any position are to be demonstrated satisfactorily.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, addressed the testing of the mooring winches in a test procedure

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Recommendation:

- The test procedure for the mooring winches should address pre-trials testing of the system under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Lifeboat Davits

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 2103-87	Visual inspection only for the ships davits. Other required tests should be in accordance with the classification societies.
IMO Resolution A.689(17) pp. 145	Lowering speed of the lifeboat while both loaded and unloaded is to be demonstrated. Also, perform a brake test to accommodate 10% over the working load and a lifeboat/rescue boat recovery test to be shown.
46 CFR 199.45	Operational demonstration of survival craft & lifeboat launching appliances at loads ranging from light load to 10% overload.
DNV 3/6-2	The administration requires life-saving appliances to be subjected to any production test deemed necessary to ensure that they are manufactured to the same standard as the approved prototype.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards, both foreign and domestic, test the lifeboat davits in a test procedure.
- The lifeboat davit test procedure could be combined with the rescue boat handling and lifeboat operations test procedures.

Recommendation:

Test procedure for the lifeboat davits and lifeboat operations should address pre-trials testing of the system under normal working conditions.

Test Procedure Title: Rescue Boat Handling and Operations

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
IMO Resolution A.689(17) pp. 145	Lowering speed of the lifeboat while both loaded and unloaded is to be demonstrated. Also, brake test to accommodate 10% over the working load and a lifeboat/rescue boat recovery test to be shown.
CFR 199.45	Operational demonstration of survival craft & rescue boat launching appliances at loads ranging from light load to 10% overload. Also demonstrate the proper condition and operation of the rescue boat, including engines and release mechanisms.
DNV 3/6-2	The administration requires life-saving appliances to be subjected to any production test deemed necessary to ensure that they are manufactured to the same standard as the approved prototype.
SOLAS III-B Reg 14	Each rescue boat shall be stowed in a state of readiness for launching in not more than 5 minutes.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, had the testing of the rescue boat handling and operations in a test procedure.
- This test procedure could be combined with the lifeboat davit and lifeboat operations test procedures.

Recommendation:

Test procedure for the rescue boat handling and operations should address pre-trials testing of the system under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Lifeboats

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
CFR 199.45	Operational demonstration of lifeboats and rescue boats, including engines and release mechanisms.
DNV 3/6-2	The administration requires life-saving appliances to be subjected to any production test deemed necessary to ensure that they are manufactured to the same standard as the approved prototype.
SOLAS III-B Reg 13, Reg 26 Reg 28	All survival craft provided for abandonment of the ship by all persons on board shall be capable of being launched with their full complement of persons and equipment within 10 minutes from the abandon ship signal. With the ship making headway at speeds up to 5 knots in calm water, lifeboats shall be capable of being launched.

Comments:

- Prior to Sea Trials, demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, had the testing of the lifeboat handling operations in a test procedure.
- This procedure could be combined with the lifeboat davit and rescue boat operations.

Recommendation:

The test procedure for the lifeboat operations should address pre-trials testing and Sea Trials testing of the system under normal working conditions..

Test Procedure Title: Elevator

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS Construction of Shipboard Elevators Guide	Extensive testing of all elevator componentry is to be accomplished after on-board installation.
ASTM F 916	After elevator installation and before being put into service, elevator installation, including safety devices, is to be proven. Most testing requirements are similar to ABS.

Comments:

- After on-board installation, demonstrate proper installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, had the testing of the elevators in a test procedure.

Recommendation:

The test procedure for the elevators should address pre-trials testing of the system under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Personnel Watertight Doors

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 1/2.1.1	After installation, all watertight doors and associated bulkheads are to be subjected to a hose test to prove tightness.
LR 3/1.8.3.2	Once in place, a pressure or leak test may be performed on the watertight doors.
MSM 6F5.f	If practicable after installation, water test is required at the design pressure; otherwise, a hose test over 30 psi is acceptable.
JIS 2314-90	Watertight sliding doors are to be tested by suitable means under a hydraulic test pressure of maximum working pressure without leakage. Inspection may be omitted by agreement between the manufacturer and purchaser.
DNV 3/1-75	Weather/water tight closing appliances not subjected to pressure tests are to be hose tested. Functional test of all water tight doors.
CFR 91.25-25	All watertight doors shall be operated locally by manual power and also by hydraulic or electric power if fitted. If fitted with remote controls, doors shall also be operated by remote control apparatus.

Comments:

- Prior to Sea Trials, hose test door for tightness.
- Demonstrate proper system installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, had the testing of the personnel watertight doors in a test procedure.

Recommendation:

The test procedure for the personnel watertight doors should address pre-trials testing of the system under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Portable Davits

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 2103-87	Visual inspection only for the ships davits. Cites that other tests performed should be in accordance with the classification societies.
ABS Certification of Construction and Survey of Cargo Gear on Merchant Vessels, Sec. 3.3.1	Before the cargo gear is placed in service, it is to be tested as an entire unit on the vessel to listed criteria. After being tested, all cargo gear is to be examined to see whether any part has been injured or permanently deformed by the test.

Comments:

- After on-board installations, demonstrate proper system operations.
- Other shipyards benchmarked, both foreign and domestic, have the portable davits as a test procedure.

Recommendation:

The test procedure for the portable davits should address pre-trials testing of the system under normal working conditions.

Test Procedure Title: Doors, Hatches, and Scuttles

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 2318-84	No testing for weathertight doors or hatches. Sliding watertight doors are as stated in personnel watertight doors.
DNV 3/1-75,79	Weather/water tight closing appliances not subjected to pressure tests are to be hose tested. All weather/water tight doors and hatches are to be function tested. Hatch covers are to be chalk tested after installation.

Comments:

- Prior to Sea Trials, hose test doors, hatches, and scuttles for tightness.
- Demonstrate proper installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, had the testing of the doors, hatches, and scuttles in a test procedure.

Recommendation:

The test procedure for the doors, hatches, and scuttles should address pre-trials testing of the system under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Cathodic Protection System

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21.1	Requires demonstration to Surveyor's satisfaction.
IEEE 46.1	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
JIS 8072-86(IEC 92-401/11/56)	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.
LLOYD 6/2/20.2.4	All essential and other important equipment are to be operated under service conditions.
DNV 4/4/9/E/101	After installation is complete and before vessel is placed in commission, the entire electric plant should be thoroughly tested.

Comments:

- There are no specific requirements for testing cathodic protection systems.
- The general testing statements regarding operational checks to the satisfaction of the Surveyor are applicable.
- Pipe pressure tests, IR tests (before launch on anodes), and system operational tests (after launch).
- Operate cathodic protection system and take/monitor readings all through the trials.

Recommendation:

The test procedure for the cathodic protection system should address installation checks including IR of anodes, reference cells, and associated cabling. Individual power supplies will be operationally tested. Verification of system can be accomplished during Sea Trials.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Commissary Equipment

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
IEEE45 46.2.5 IEEE 45/46.2.6	Ranges, bake ovens, and other heating/cooking equipment should be tested to show that their heating elements function satisfactorily.
ABS 4/5.21.1 JIS 8072-86(IEC 92-401/7/63) LLOYD 6/2/20.2.6 DNV 4/4/9/E100.	All CSARB's require an operational verifications, generally expressed as a generic test statement.

Comments:

- Prior to Sea Trials, demonstrate proper equipment installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, test the commissary equipment in a test procedure
- Often, operational tests are witnessed by the customer only.

Recommendation:

The test procedure for the commissary equipment should address pre-trials testing under normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Medical, Laundry, and Workshop Equipment

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 4/5.21.1 IEEE45 46.2.5 JIS 8072-86(IEC 92-401/7/63) LLOYD 6/2/20.2.6 DNV 4/4/9/E100.	All CSARB's require an operational verifications, generally expressed as a generic test statement.

Comments:

- Other shipyards benchmarked did not perform an operational test for medical equipment.
- Other shipyards benchmarked varied with regard to testing the laundry equipment and workshop equipment in a specific test procedure.

Recommendation:

A single test procedure is sufficient to address the requirements of testing medical, laundry, and workshop equipment. The Medical, Laundry, and Workshop Test Procedure should address operational testing of the equipment under normal conditions. Such testing shall supplement, but not duplicate, the efforts of first article testing and installation inspections. Water supply and drainage should be tested with their respective systems, where applicable.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Anchor Windlass

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 3/3-36	Shop pressure test of individual parts and, after installation on board, an anchoring test at various water depths and speeds to show satisfactory function of windlass and brake.
ABS 1/2.3 4/1.11.1	Anchor windlass to be tested under normal working conditions. The anchor windlass must be capable of lifting each anchor with 82.5m (45 fathoms) length of chain submerged and hanging free. A final underway trial is to be performed on the anchor windlass.
LR 3/13.7	Demonstrate the anchor windlass is capable of lifting the anchor from a depth of 82.5 m to a depth of 27.5m at a mean speed of 9m/min during trails.
JIS 6714-95	No-load, load, brake, and performance tests are required, but it is not specified whether they are shop, waterborne, or trials tests. No-load test for a duration of 30 min. at rated speed. The anchor windlass shall be able to pull the working load for a duration of 30 min., and the overload pull (150% of working) for 2 min. at reduced speed. The rated hoisting speed shall be 9m/sec or more. The brake test shall prove the holding power of the brake by holding 130% of the working load, and shall also control the load by applying the brake at each half chain length.

Comments:

- Prior to Sea Trials, perform static and dynamic tests, and demonstrate proper systems operations.
- At Sea Trials, demonstrate proper system installation and operations under normal working conditions, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, had a separate test procedure for the anchor windlass.
- The test procedure addressing the anchor windlass shall satisfy the various requirements of all CSARB's.

Recommendation:

SYSTEM TESTING AND INSPECTION REQUIREMENTS

The test procedure for the anchor windlass should address pre-trials testing of the equipment under simulated operational working conditions. The operation of the anchor windlass under normal operating conditions shall also be demonstrated as part of the Sea Trial.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Sea Chests and Overboards

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 4/1-9	No testing requirements, only design guidance.
ABS 1/2	Seachests/overboards are not specifically called out; however, seachests are referenced in section 3/7.15, which cites section 1/2, resulting in a hydrostatic test requirement.
CFR 56.50-95	No testing requirements, only design guidance.

Comments:

- Prior to launch, all seachests and overboards should be pressure tested for leaks, ensuring hull integrity.
- There are no specific test requirements for seachests and overboard.
- Other shipyards benchmarked, both foreign and domestic addressed sea chests as an in-process inspection.

Recommendation:

A separate test procedure is not required and portions can be accomplished as in-process inspection. Hydrostatic requirements can be covered under Piping Systems Hydrostatic Test Procedure.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Tank and Compartment Tests

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS 1/2.1.2	Unless air testing has been approved as an alternative, tanks are to be hydrostatically tested before or after the vessel is launched. Watertight/weathertight bulkheads are to be hose tested. Testing may be accomplished after a coating has been applied as long as the Surveyor has approved, by visual inspection, the welds at joints and penetrations prior to coating application.
46 CFR 58.50-5, 72.01-25	Vented tanks are to be tested hydrostatically, bulkheads are to be hose tested. Unvented tanks to be tested as a pressure vessel.
DNV 3/1-4	Hydraulic, air tightness, and hose testing are the 3 types of structural tests employed by DNV. Water testing may be accomplished after a coating system is applied while air testing must be accomplished prior to coating the welds.

Comments:

- Prior to Sea Trials, the tanks and bulkheads shall be tested by hydraulics, hydrostatics, or with air to ensure structural and/or watertight and weathertight integrity.
- Other shipyards benchmarked addressed tank testing as an in-process inspection, not a test procedure.

Recommendation:

Tank testing does not require a separate test procedure, as the necessary testing can be accomplished as an in-process inspection with documentation available for customer and CSARB review.

Test Procedure Title: Windows

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
ABS Table 1/2.1	After all bulkhead penetration installations, a hose test is required for either watertight or weather tight bulkheads to prove proper installations.

Comments:

- Prior to Sea Trials, hose testing of the windows shall be accomplished to prove tightness. Operations of electrical window devices should also be proven.
- Other shipyards benchmarked, both foreign and domestic, addressed window testing as a test procedure.

Recommendation:

The test procedure for the ship's windows should address hose testing and electrical operation prior to trials.

Test Procedure Title: Accommodation/Pilot Ladders

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 2621,22-85	Visual and strength inspection of ladders, without specification of where or when the inspections are to be performed. No specifications for hoist.
DNV	No specific test requirements, only design stipulations.
SOLAS V/17	No specific test requirements, only design stipulations.
NVIC 4-91	Operational test of the hoist, including a 10% overload test after on-board installation to Administrations satisfaction. No static test requirement for the ladder.
46 CFR 97.90	No specific test requirements.
ABS Certification of Construction and Survey of Cargo Gear on Merchant Vessels, Sec. 3.3.1, 3.3.4ABS	On all types of winches, efficient means are to be provided to stop and hold the load in any position and such means shall be demonstrated.

Comments:

- After on-board installation, the accommodation and pilot ladder winches should be tested to prove system installations and operations.
- Other shipyards benchmarked, both foreign and domestic, test the accommodation and pilot ladders by test procedure.

Recommendation:

The test procedure for the accommodation and pilot ladder winches should address pre-trials testing of the equipment under simulated normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Hose Handling Cranes

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 6/1-7	After installation on board, functional testing of the crane is to be carried out in accordance with the "Rules for Certification of Lifting Appliances".
ABS Guide for Certification of Cranes	Proof load testing at various boom situations, operation of all brakes and fail-safe devices, and examination for the damage of parts after test.

Comments:

- Prior to Sea Trials, demonstrate proper equipment installation and operations, including all controls and safety devices.
- Other shipyards benchmarked, both foreign and domestic, addressed testing of the hose handling cranes in a test procedure.

Recommendation:

The test procedure for the hose handling cranes should address pre-trials testing of the system under simulated normal working conditions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Noise Survey

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
NVIC 12-82	Noise surveys are to be conducted in multiple spaces and conditions, both in port and underway.
ABS	Also cites IMO Assembly Resolution A.468 (XII), using the same information as the CFR above.
DNV 5/12-3	Test program to measure noise levels is to be approved based on ISO 2923 and DNV standard and is to be performed at sea under prescribed conditions.
JIS 0801-89, 0904-81	Noise levels measurements are broken into two areas, machinery spaces and accommodations. Tests to be carried out if necessary at Sea Trials. Detailed procedures exist for measurements.

Comments:

- While operating multiple machinery under prescribed conditions at Sea Trials, noise surveys are to be conducted in various spaces.
- The surveys are to prove that the noise for the various spaces are within acceptable limits.
- Other shipyards benchmarked varied greatly as to the conduct of noise surveys. Some shipyards addressed noise testing as a test procedure, and others treated noise testing as an inspection, or performed no testing at all.

Recommendation:

A separate test procedure for the noise survey is not required, surveying of the noise levels under prescribed conditions should be accomplished as part of the Sea Trials Test Procedure.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Inclining Experiment and Deadweight Survey

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Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
DNV 3/4-10	Every passenger and cargo ship is to be inclined upon completion and the lightweight displacement and CG determined. Inclining may be eliminated if a sister ship was inclined satisfactorily. In this case, a lightweight survey is to be performed and must be within a lightweight displacement deviation of 2% or an LCG deviation not to exceed 1%. An incline test may be required if these are exceeded.

Comments:

- Prior to Sea Trials, perform an inclining experiment to determine the lightweight displacement and CG of the ship.
- Other shipyards benchmarked, both foreign and domestic, have a test procedure addressing the inclining experiment.

Recommendation:

The Inclining Experiment Test Procedure shall prove positive stability, and contain the necessary calculations and methods to determine the GM. The procedure used to conduct the experiment is outlined in a separate set of work instructions.

SYSTEM TESTING AND INSPECTION REQUIREMENTS

Test Procedure Title: Dock Trials

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 0801-89	Various testing of main engine operation with the propeller connected and disconnected. Dock Trials may be omitted if preliminary trials are performed.

Comments:

- Prior to Sea Trials, perform a Dock Trials to confirm the readiness of the propulsion plant and ancillary equipment necessary for Sea Trials.
- Other shipyards benchmarked, both foreign and domestic, have a Dock Trials Test Procedure.

Recommendation:

The Dock Trials Test Procedure should address the readiness checks of the ship for Sea Trials.

Test Procedure Title: Sea Trials

Requirements:

Classification Society and Regulatory Bodies	
Section	**Description**
JIS 0801-89	Sea Trials are required to confirm reliability and characteristics of the propulsion plant. Tests include guarantee speed, progressive speed, endurance, fuel oil consumption, astern, minimal rotational speed, starting, and unmanned machinery operations. Other measurements, including shafting torsional vibration, vibration, noise, exhaust gas economizer evaporation, and distilling plant capacity, shall be performed only if necessary. An overload test may be carried out in the case of an internal combustion engine.
DNV 4/2-12	After conclusion of the running in program prescribed by the engine manufacturer, the main engines are to be tested for 4 hours at 100% rated power, 2 hours at normal continuous cruise power, 30 minutes at 110% power, and in reverse at 70% of nominal propeller speed.
LR 5/1.5.2	For all types of installations, Sea Trials are to be of sufficient duration to prove machinery under power.

Comments:

- Sea Trials is performed to confirm the reliability and the characteristics of the propulsion plant as well as to perform other required tests proving system installations and operations while at sea.
- Other shipyards benchmarked, both foreign and domestic, have a Sea Trials test procedure.

Recommendation:

The Sea Trials Test Procedure should address Sea Trials testing of the propulsion plant and other pertinent tests.

Test Procedure Comparison Matrix

TM	TITLE	U.S.	KOREA	EUROPE	JAPAN	U.S.	RECOMMENDATION
8501	Propulsion System Motors / Rdn Gear	TM	DT	DT	DT	TM	Test procedure required. May be split into two test procedures if applicable.
8502	Shafting Alignment	INSP	INSP	INSP	INSP	N/F	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8503	Machinery Sea Water Cooling	TM	TM	TM	TM	TM	Test procedure required.
8505	Machinery Plant Handling Padeyes	N/F	N/F	N/F	N/F	TM	Test procedure not required. Perform in-process visual inspection only.
8506	Mdg's/Aux Boiler/Incinerator Exh Sys	N/F	N/F	INSP	N/F	TM	Separate test procedure not required. Combine with Piping System Hydro testing (8702)
8507	Lube Oil Fill/ Transfer/ Purification Systems	TM	TM	TM	TM	TM	Test procedure required.
8511	Main Propulsion Lube Oil System	TM	TM	TM	TM	TM	Test procedure required.
8512	Starting Air Compressors And System	TM	TM	TM	TM	TM	Test procedure required.
8513	Ship Service And Control Air Equipment	TM	TM	TM	TM	TM	Test procedure required.
8514	Segregated Ballast System	TM	TM	TM	TM	TM	Test procedure required.
8515	Steam & Condensate System	TM	TM	TM	TM	TM	Test procedure required.
8520	Fo Quick Closing Valves	TM	TM	TM	TM	TM	Test procedure required.
8521	Ht/Lt Fresh Water Cooling Systems	TM	TM	TM	TM	TM	Test procedure required.
8524	Stern Tube Lube Oil System	TM	TM	TM	TM	TM	Test procedure required.
8601	Electric Power Insulation Resist	INSP	TM	TM	TM	TM	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8602	Electrical Protective Devices	N/F	N/F	N/F	N/F	TM	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8603	Ship Service Gen. Installation Tests	TM	TM	TM	TM	TM	Separate test procedure not required. Combine with SS Generator operational testing (8604)
8604	Ship Service Gen. Operational Tests	TM	TM	TM	TM	TM	Test procedure required.
8605	Emergency Diesel Generator	TM	TM	TM	TM	TM	Test procedure required.
8606	Generator Parallel Operation	TM	TM	TM	TM	TM	Separate test procedure not required. Combine with SS Generator operational testing (8604)

KEY: TM=Test Procedure INSP=Inspection ST=Sea Trial N/F=Not Found

TASK 2 – ATTACH. B

Test Procedure Comparison Matrix

TM	TITLE	U.S.	KOREA	EUROPE	JAPAN	U.S.	RECOMMENDATION
8607	Batteries And Chargers	TM	TM	N/F	N/F	TM	Test procedure required.
8608	Transformers	N/F	N/F	N/F	N/F	N/F	Test procedure not required, IR readings taken as in-process inspection.
8610	Electrical Instruments	N/F	N/F	N/F	N/F	TM	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8611	Switchboards And Circuit Breakers Verification	TM	TM	TM	TM	TM	Test procedure required.
8612	Lighting Systems Insulation Resistance	N/F	N/F	N/F	N/F	N/F	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8613	Lighting System Operation	TM	TM	TM	TM	TM	Test procedure required.
8614	Photometric Survey	N/F	N/F	N/F	N/F	N/F	Test procedure not required. Customer requirement only.
8616	Mccs Insulation Resistance Tests	N/F	N/F	N/F	N/F	N/F	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8617	Mccs Design Verification Tests	TM	TM	TM	TM	TM	Test procedure required.
8618	Mccs Calibration And Alarms	TM	TM	TM	TM	TM	Test procedure required.
8619	Mccs Controls And Operation	TM	TM	TM	TM	TM	Test procedure required.
8621	Electric Mov's	TM	TM	TM	TM	TM	Test procedure required.
8650	Electromag Radiation Safety Survey	N/F	N/F	N/F	N/F	N/F	Test procedure not required. Customer requirement only.
8651	Rf Transmission Lines	N/F	N/F	N/F	N/F	N/F	Test procedure not required. Customer requirement only.
8655	Navigation And Signal Lights	TM	TM	TM	TM	TM	Test procedure required.
8656	Integrated Bridge Electronic Systems	TM	TM	TM	TM	TM	Test procedure required.
8659	Ic Systems Insulation Resistance Tests	N/F	N/F	N/F	N/F	N/F	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8660	Dial Telephone System	TM	TM	TM	TM	TM	Test procedure required.
8661	Sound Powered Telephones	N/F	N/F	N/F	N/F	TM	Test procedure required.
8662	General Alarm And Announcing System	TM	TM	TM	TM	TM	Test procedure required.

KEY: TM=Test Procedure INSP=Inspection ST=Sea Trial N/F=Not Found

TASK 2 – ATTACH. B

Test Procedure Comparison Matrix

TM	TITLE	U.S.	KOREA	EUROPE	JAPAN	U.S.	RECOMMENDATION
8663	Entertainment System	TM	TM	TM	TM	TM	Test procedure required.
8664	Gas Detection System	TM	TM	TM	TM	TM	Test procedure required.
8665	Fire Detection System	TM	TM	TM	TM	TM	Test procedure required.
8667	Misc. Alarm And Warning Systems	TM	TM	TM	TM	TM	Test procedure required.
8670	Radio Communication Equipment	TM	TM	TM	TM	TM	Test procedure required
8671	Ships Whistles	TM	TM	TM	TM	TM	Test procedure required
8673	Shipboard Pc Network	TM	TM	TM	TM	N/F	Test procedure required
8674	Mccs Periodic Test	TM	TM	TM	TM	TM	Test procedure required
8675	Uhf Internal Communication Systems	TM	TM	TM	TM	TM	Test procedure required
8676	Cctv System	TM	TM	TM	TM	N/F	Test procedure required
8701	Tank Level Indicators	TM	TM	N/F	N/F	TM	Test procedure required
8702	Piping Systems Hydrostatic Testing	TM	N/F	N/F	TM	TM	Test procedure required.
8703	Mechanical Instruments Calibration	N/F	N/F	N/F	N/F	N/F	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8705	Ventilation Fans And Controls	TM	TM	TM	TM	TM	Test procedure required.
8706	Fire Dampers	TM	TM	TM	TM	TM	Separate test procedure not required. Combine with Ventilation Fans and Controls (8705)
8707	Ventilation Systems Balance	TM	TM	TM	TM	TM	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8708	Accom Heating Equipment	TM	TM	TM	TM	TM	Test procedure required.
8710	Accommodation Air Conditioning Test	TM	TM	TM	TM	TM	Test procedure required.
8712	A/C Plants	TM	TM	TM	TM	TM	Test procedure required.
8714	Ships Stores Reefer Plants	TM	TM	TM	TM	TM	Test procedure required.
8715	Auxiliary Boiler And Services	TM	TM	TM	TM	TM	Test procedure required.
8719	Drain And Vent Piping	N/F	N/F	N/F	N/F	N/F	Test procedure not required. Should be operational test with related TM's
8722	Mach'y Bilge & Oily Waste Transfer System	TM	TM	TM	TM	TM	Test procedure required.
8723	Distilling Plant	N/F	N/F	N/F	N/F	TM	Separate test procedure not required. Capacity test performed as part of Sea Trial.
8725	Potable Water System	TM	TM	TM	TM	TM	Test procedure required.

KEY: TM=Test Procedure INSP=Inspection ST=Sea Trial N/F=Not Found

TASK 2 – ATTACH. B

Test Procedure Comparison Matrix

TM	TITLE	U.S.	KOREA	EUROPE	JAPAN	U.S.	RECOMMENDATION
8727	Fuel Fill /Transfer/ Purification Systems	TM	TM	TM	TM	TM	Test procedure required.
8728	Compressed Air Distribution Systems	TM	TM	TM	TM	TM	Test procedure required.
8729	Co2 Fire Extinguishing Systems	TM	TM	TM	TM	TM	Test procedure required.
8730	Firemain And Foam Systems	TM	TM	TM	TM	TM	Test procedure required.
8731	APC Fire Extinguishing Systems (Galley Hoods)	N/F	N/F	N/F	N/F	N/F	Separate test procedure not required. Combine with Ventilation System TM (8705)
8732	Steering Gear	TM	TM	TM	TM	TM	Test procedure required.
8736	Marine Sanitation Device	TM	TM	TM	TM	TM	Test procedure required.
8737	Stores Handling Cranes	TM	TM	TM	TM	TM	Test procedure required.
8738	Incinerator	TM	TM	TM	TM	TM	Test procedure required.
8739	Inert Gas System	TM	TM	N/F	N/F	TM	Test procedure required.
8740	Cargo Oil System	TM	TM	N/F	N/F	TM	Test procedure required.
8741	Fixed Tank Cleaning System	TM	TM	N/F	N/F	TM	Test procedure required.
8742	Ballast Mud Dispersant System	N/F	N/F	N/F	N/F	N/F	Test procedure required.
8743	Hovs	TM	TM	TM	TM	TM	Test procedure required.
8744	Engine Room Bridge Crane	TM	TM	TM	TM	TM	Test procedure required.
8801	Miscellaneous Padeyes	N/F	N/F	N/F	N/F	TM	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8805	Mooring Winches	TM	TM	TM	TM	TM	Test procedure required.
8806	Lifeboat Davits	TM	TM	TM	TM	TM	Test procedure required.
8807	Rescue Boat Handling / Ops	TM	TM	TM	TM	TM	Test procedure required.
8808	Lifeboats	TM	TM	TM	TM	TM	Test procedure required.
8809	Elevator	TM	TM	TM	TM	TM	Test procedure required.
8810	Personnel Watertight Doors	TM	TM	TM	TM	TM	Test procedure required.
8814	Portable Davits	TM	TM	TM	TM	TM	Test procedure required.
8815	Doors, Hatches And Scuttles	TM	TM	TM	TM	TM	Test procedure required.
8816	Cathodic Protection System	N/F	N/F	N/F	N/F	TM	Test procedure not required. Perform in-process inspection.
8817	Commissary Equipment	TM	TM	TM	TM	TM	Test procedure required.
8818	Self Contained Reefer Eqpt	N/F	N/F	N/F	N/F	TM	Separate test procedure not required. Combine with Commissary Equipment TM (8817)
8819	Medical Equipment	N/F	N/F	N/F	N/F	TM	Combine with laundry and workshop

KEY: TM=Test Procedure INSP=Inspection ST=Sea Trial N/F=Not Found

TASK 2 – ATTACH. B

Test Procedure Comparison Matrix

TM	TITLE	U.S.	KOREA	EUROPE	JAPAN	U.S.	RECOMMENDATION
							equipment
8820	Laundry Equipment	TM	TM	TM	TM	TM	Combine with medical and workshop equipment
8821	Workshop Equipment	TM	TM	TM	TM	TM	Combine with laundry and medical equipment
8826	Anchor Windlass	TM	TM	TM	TM	TM	Test procedure required
8852	Seachests And Overboards	INSP	N/F	N/F	INSP	N/F	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8853	Tank And Compartment Tests	INSP	N/F	N/F	INSP	TM	Test procedure not required. Perform in-process inspection with documentation available for CSARB and customer review.
8854	Windows	TM	TM	TM	TM	TM	Test procedure required
8855	Accom/Pilot Ladders	TM	TM	TM	TM	TM	Test procedure required
8856	Hose Handling Cranes	TM	TM	TM	TM	TM	Test procedure required
8901	Noise Survey	INSP	TM (ST)	N/F	N/F	TM	Separate test procedure not required, perform test as part of Sea Trials
8902	Inclining Experiment / Deadweight Survey	TM	TM	TM	TM	TM	Test procedure required
8920	Dock Trials	TM	TM	TM	TM	TM	Test procedure required
8930	Sea Trials	TM	TM	TM	TM	TM	Test procedure required

KEY: TM=Test Procedure INSP=Inspection ST=Sea Trial N/F=Not Found

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Task 3 - Standard Ship Test Plan

Project 6-95-1

Prepared For:
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Introduction/Abstract

The intent of this project is to investigate and evaluate testing requirements and test criteria as outlined by the Classification Societies and Regulatory Bodies (CSARB), and to develop a mutually agreeable test program to include a test plan and test procedures. Conversely, the purpose of this project is *not* to evaluate all production processes and inspection activities required for ship construction. The team has maintained a focus on system testing plans and procedures in an effort to better understand and coordinate the intentions of the CSARB.

Objective

The focus of Task 2 was to identify CSARB restrictions to testing during certain phases of construction, and establish a test schedule that will satisfy the requirements and restrictions of the CSARB.

The Test Plan developed for Task 3 is comprised of the documentation, processes, and measures used to effectively test, inspect, and commission a new vessel.

The Test Plan is comprised of general provisions related to testing, the relationship of testing to ship construction, and the need for special ship conditions and test equipment.

Approach and Rationale

Through a review of current commercial ship test plans and visits to various shipbuilding facilities, the team has developed a document which incorporates aspects of test plans throughout the industry. The Test Plan reflects current industry methods with respect to testing and trials and can be considered a *Standard Test Plan* because it satisfies all the CSARB requirements.

The *Standard Test Plan* developed for this project is comprised of several general sections which outline provisions for testing. These general sections apply to all ship types and classes. In addition to the general provisions, the *Standard Test Plan* also includes a detailed Shipboard Installation Test section. This section describes in detail the extent of testing required for each system and associated system components. The systems included in the *Standard Test Plan* presented herein are representative of common systems found on most vessels. In order to further understand the scope of the Shipboard Installation Tests, the systems common to a medium sized crude oil carrier were used as a baseline.

For the purposes of this exercise, the *Standard Test Plan* includes shipboard installation tests, commissioning test procedures, dock trials, and sea trials. Flushing of piping and piping systems is addressed as part of the Quality Plan; however, hydrostatic testing of piping and piping systems is included in the *Standard Test Plan*. The Quality Plan includes all production processes, acceptance criteria, control group authority, and production department responsibility.

Sources

Sample Test Plans evaluated for this exercise have been obtained from the following shipyards:

- National Steel and Shipbuilding Company
- Newport News Shipbuilding
- Hyundai Heavy Industries
- Avondale Industries
- Kawasaki Heavy Industries

As a rule, Test Plans are not generally used in European shipyards. Based on the results of a benchmarking trip to Northern European shipyards, the project team has determined that the information contained in their shipbuilding specification takes the place of separate Test Plan documentation. It is important to note that the shipbuilder and the owner/customer mutually agree on what the test requirements are, and in which document these test requirements are outlined.

Supplemental Test and Inspection Requirements

The Standard Test Procedures to be developed in Task 4 will include specific test criteria, expected values and allowable tolerances generated from system diagrams, cognizant engineer input, and vendor technical

data. Where the Standard Test Procedures are lacking this information, the supplemental criteria is outlined in a document known as *The Supplemental Test and Inspection Requirements.* This document is included as Attachment (B) of this report.

The Supplemental Test and Inspection Requirements document is designed for use on commercial contracts only, and addresses test and inspection requirements for equipment and systems operational testing during construction and trials.

Results

The *Standard Test Plan* not only represents a cross section of current industry practice, but also complies with the CSARB requirements. With slight modification to the specific Shipboard Installation Tests, the *Standard Test Plan* can be used to effectively outline the testing to be accomplished for any commercial vessel, built to any Classification Society Rules.

Applicability to Other Tasks

The information contained in the *Standard Test Plan* will now be used to develop the test procedures required for Task 4. The *Standard Test Plan* clearly defines the roles of the various departments involved in the test and trials process. Based on the information in the *Standard Test Plan,* a *Standard Test Procedure Format* can now be developed. The new *Standard Test Procedure Format* will be simple, and streamlined, and will reflect the current world shipbuilding methodologies. The general provisions in the *Standard Test Plan* replace information traditionally contained in the Test Procedures, and allow the *Standard Test Procedure Format* to be as general as possible. The descriptions given in the Shipboard Installation Test Section form the basis for each system Test Procedure and, coupled with the technical manual documentation, provide sufficient instruction to carry out the testing requirements.

Attachments: (A) - Commercial Standard Test Plan
(B) - Supplemental Test and Inspection Requirements

DISCLAIMER

The "Controlled Copy, Do not Duplicate" warning on each page of Task 3, Attachment A is meant only as a prototype of what shipyard personnel might print on their own proprietary test plans. Permission is hereby granted by the National Shipbuilding Research Program and the Marine Systems Division of the University of Michigan Transportation Research Institute to reproduce, download, and rewrite this material.

Approved: ________________________________
Vice President, Engineering

Approved: ________________________________
Manager, Test and Trials

Approved: ________________________________
Supervisor, Test Engineering

Revision Record			
Revision	Date	Authorizing Signature	Description of Change

1. Purpose:

The purpose of the commissioning/test and trials program is to demonstrate that the ship:

- is complete,
- complies with the contract, plans, and specifications as they affect performance, and
- is ready for acceptance.

2. Scope:

The intent of this Test Plan is to satisfy the requirements for test and inspection set forth by the Classification Societies and Regulatory bodies (CSARB). This Test Plan is based on the contract requirements of a medium size oil tanker, with a diesel electric propulsion arrangement, and includes tests and inspections performed on equipment and systems after installation by the shipbuilder. Major items of machinery and equipment, including: main propulsion motors, diesel generators, automation equipment, and selected auxiliaries will also be tested at the subcontractor s plant in accordance with the subcontractor s shop testing standards.

With regard to testing and inspection of shipboard systems it should be noted that this test plan and the test procedures that follow address system and operational testing. The Test Plan encompasses all testing that would be accomplished by the shipyard, including any preliminary inspection of system installation required to complete testing. The Test Plan does not pertain to quality assurance inspections, quality system procedures, process controls, or quality standards, applied during the shipbuilding process. Such procedures are included in reference (a), and are a function of the Quality Assurance Department.

The methods, procedures, and plan described herein have been developed based on the system testing requirements of a diesel electric crude oil tanker, and satisfy the requirements of all Classification Societies. With minor modifications this test plan can be applicable to any commercial contract awarded to any U.S. shipyard.

3. References:

a. Quality Plan
b. Test Engineering Procedures
c. Shipyard Standards for In Shop Test and Inspection Requirements

4. Definitions:

4.1. Test Plan: The documentation, processes, and measures used to effectively test, inspect, and commission a new vessel.

4.2. Test Procedures: Test procedures are instructions used to set-up, start, and demonstrate satisfactory operation of ship equipment, systems, and machinery to the customer and regulatory agencies.

4.3. Test Reports: Test Procedures which have been executed by the Test and Trials Department and have the appropriate data and necessary information to be considered complete are referred to as Test Reports.

4.4. Cognizant Engineer: A technically qualified engineer in the Machinery Systems Department who is responsible for overseeing the design, construction and testing of one or more design requirements, systems or equipment for a new construction vessel.

5. Responsibilities:

Task	Department	Personnel
Development of Test Plan and Test Procedure documentation.	Test Engineering	Test Engineers
Execution and tracking of Subcontractor Test and Inspection Plan	Test Engineering	Test Engineers
Development and incorporation of appropriate tests into relevant equipment/subsystem test procedures.	Systems Engineering	Cognizant Engineers
Planning, maintenance, and promulgation of test schedules.	Test and Trials	Test and Trial Engineers
Completion and inspection of production work required for testing	Production	Ship Manager
Execution of Test Plan and Procedures.	Test and Trials	Test and Trial Engineers
Notification to Owner and regulatory bodies of scheduled tests.	Test and Trials	Test and Trial Engineers
Final internal review/approval of completed test procedures (test reports).	Test and Trials	Test and Trial Engineers
Transmittal of the test documentation to Owner and CSARBs for final approval.	Engineering	Project Engineer

6. Development:

6.1. The Test Plan is developed in conjunction with the CSARB and customer requirements, and reference (b). The Test Plan is designed to demonstrate hull,

machinery, equipment, outfits, and systems after they have been installed by the shipyard.

6.2. The Test Procedures included in the Test Plan address all major equipment and systems, and contain tests required by the CSARB for vessel certification. The details of the Test Procedures are sufficient to fully function test all equipment as component parts of complete systems, or as complete systems.

6.3. The specific test criteria, expected values and allowable tolerances identified in the test procedures are generated from system diagrams, cognizant engineer input, and vendor technical data. Where test procedures are lacking this information, the supplemental criteria outlined in reference (c) shall be consulted.

6.4. Cognizant Engineers will use ship specification requirements, CSARB rules, and past history data provided by Test Engineering to guide in the identification of test requirements which will constitute the Test Procedures.

6.5. Design verification and design validation consists of engineering checks, qualification testing, comparison to existing designs, and approval by regulatory bodies as outlined in reference (a).

6.6. The Production Test Schedule drives the schedule for development of Test Procedures through the Engineering Planning and Control System.

7. General Provisions:

7.1. Test Procedures will be sent to the Owner for final review and approval a minimum of 30 days prior to the scheduled start of testing.

7.2. All tests will be completed to demonstrate that the system meets specification and CSARB requirements to the satisfaction of the owner and regulatory bodies.

7.3. The tests will be witnessed by the Owner and/or CSARB as shown on Attachment 1.

7.4. The Owner and the CSARB will be notified the day prior to the scheduled start of the test. Should the Owner fail to attend a test that he has been notified of, the Owner will be deemed to have waived his rights to inspection, and shall accept the results of the test as witnessed by the CSARB and/or the Builder.

7.5. The Builder will be responsible to insure that all tests and trials conducted by the Builder are completed in accordance with the requirements of the Owner-approved Test Procedure, and all applicable regulatory body requirements. The Builder will

also insure that all tests and trials are properly witnessed and signed-off, on appropriate forms, by a representative of the Owner and/or regulatory bodies.

7.6. The Owner and regulatory body shall have access to monitor the in-process work that pertains to this project, but shall not disturb the work in-progress, nor cause cost impact to the Builder.

7.7. The Builder will be responsible for recording and analyzing of test data. Data will normally be taken from installed ships instrumentation, however the Builder will provide additional instrumentation, personnel, and equipment when necessary for testing. The Builder will ensure that all installed instrumentation will be in calibration.

7.8. The Builder will provide Test Reports to the Owner indicating the results for each item that is tested. These documents will be distributed in accordance with the specification requirements.

8. Test Procedures

8.1. The Builder will prepare test procedures for the tests to be performed in the Test Plan, including tests for Dock Trials, Sea Trials, and Inclining Tests. The procedures will include:

- Identification of the equipment to be tested,
- Acceptance criteria for the test,
- Space for data recording,
- Space for comments by Builder, CSARB, and Owner observers, and
- Space for observer signatures.

8.2. Procedures will be developed to cover all machinery/equipment/systems identified in the Test Plan.

8.3. Generally, only one ship's system will be included in a given procedure, however there are exceptions to this rule. The hydrostatic test procedure, which includes several systems, will be addressed on a single procedure. Static load tests of fittings will also be addressed on a single procedure. Automation systems, in which the interrelated machinery automation, monitoring, and alarms are tested together will also be addressed on a common test procedure.

8.4. The Builder will conduct such preliminary system commissioning tests as he deems necessary to assure system readiness prior to official testing. The builder will notify Owner and CSARB inspectors only after satisfactory preliminary system test results have been achieved. The Builder will normally give one day advance notice to the Owner's representatives for tests in the shipyard.

8.5. All precautions to ensure safety of life and limb and equipment protection, in accordance with standard shipyard safety practices, shall be observed at all times.

9. Shipboard Installation Tests

9.1. General

This Test Plan requires that all systems and equipment be tested in accordance with CSARB requirements, the following tests are specifically designed to meet such requirements. The Test Procedures described herein satisfy only the CSARB requirements specific to testing, inspection of testing, and trials. Requirements pertaining to manufacturer’s testing, first article testing, component testing, in-service or periodic testing, and quality inspection are not considered part of the Test Plan or Procedures. Requirements for quality inspection and in-process inspection are addressed in separate Quality and Inspection Plans.

9.2. Pumps And Piping Systems

All motor driven pumps will be tested along with the operational commissioning tests of the system. In conjunction with the operational run, cold and hot insulation resistance of the motor and controller and motor running current will be checked. Simulated design conditions, as practical, will be obtained while conducting these tests. Operation of items such as heaters, controls, alarms, and indicating devices will be demonstrated. It should be noted that the sea trial affords an opportunity to observe the operation of equipment which cannot be brought to design conditions dockside.

9.2.1. Piping Systems HydrostaticTesting

Each installed piping system will be hydrostatically tested or service tested to demonstrate strength and tightness. Hydrostatic or pneumatic testing will be

accomplished in accordance with the CSARB rules and the guidelines set forth in the Inspection and Quality Systems Manual.

9.2.2. Machinery Seawater Cooling System

The machinery sea water cooling system will be operated to prove proper installation and operation of all associated equipment including the sea water cooling pumps, suction strainers, relief/regulating valves, and local/remote controls.

9.2.3. HT/LT Fresh Water Cooling Systems

The low temperature and high temperature fresh water cooling systems provided as the cooling medium for the main and auxiliary machinery systems will be operationally tested. Included in the testing will be demonstrations of freshwater cooling pumps, MGE jacket water cooling pumps, central fresh water coolers, MDG jacket water coolers, MDG jacket water pre-heaters, expansion tanks, chemical dosage and testing system, and fresh water drain tanks.

9.2.4. Steam and Condenstate System

The steam system will be demonstrated to prove proper flow rate, temperature and pressure required for the normal tank cleaning at-sea ship operation, tank heating and shipboard accommodation uses. The steam drains system used to collect condensate from heating coils and heat exchangers will be operationally tested. The steam drains systems is separated into clean drain returns and contaminated drain returns, and testing will prove proper operation of the following equipment: boiler feed pumps, contaminated drain inspection tanks, cascade tanks, contaminated drain coolers, dump condensers, feedwater treatment system, and a feedwater sample cooler.

9.2.5. Machinery Bilge and Oily Waste Transfer System

The main bilge systems provided for dewatering, and the bilge housekeeping system provided for collecting and processing oily waste from the machinery rooms and steering gear rooms will be demonstrated. Both the oily waste transfer and bilge water separation systems will be operationally tested to verify that performance complies with regulatory body requirements. The bilge oily water separator, separator pumps, house keeping pumps, and deepwell bilge pumps, will be demonstrated. The proper alignment of the waste oil tanks, and bilge water holding tanks and operation of the oil content monitor will be confirmed.

9.2.6. Potable Water System

The hot and cold potable water system will be demonstrated to prove sufficient supply to accommodation areas, laundry equipment, lavatories, showers, and sinks, as well as galley and other culinary services. The operational test of the system will prove proper operation of the following equipment: hot water heater,

hydropneumatic tank, storage tanks, fresh water potable pumps, distilled water transfer pumps, and a hot water circ pump.

9.2.7. FO Fill, Transfer, and Purification Systems

The test of the FO transfer system will prove the vessels capability to load marine diesel oil, low sulfur and conventional heavy fuel oil (HFO) from the midship manifold into appropriate dedicated fuel tanks. The complete fuel system including filling, storage, transferring, discharging, and purification will be demonstrated.

The FO transfer system test will show proper alignment of all associated FO storage, settling, and overflow tanks, and proper operation of FO and DO transfer pumps, associated filters, strainers, meters. The service systems of both heavy fuel and marine diesel oil for the main diesel generators, emergency generator, boiler and incinerator will be proven along with the operational test of each respective system.

Additionally, each of the two heavy fuel oil centrifugal purification systems will be tested to confirm proper operation. The demonstration will include operation of fuel oil supply pumps, suction strainers, a diesel oil supply pump, steam-type heaters (with in-line sterilizers), flowmeters, instrumentation, valves and all necessary piping.

9.2.8. Firemain and Foam Systems

Fire and general service pumps and piping systems will be hydrostatically tested as noted above. The capability to supply the firemain with sufficient pressure and volume and dictated by the CSARB will be demonstrated. The fire and washdown system will be tested to prove capability for anchor chain washing, supply of driving water to bilge eductors, the deck foam system, house front water spray system, and the deluge system.

The small bore hose reel units provided port and starboard on each deck of the accommodation for first aid fire fighting purposes will be demonstrated.The cargo deck foam system test will consist of an operational run of the foam liquid supply pump, foam storage tank, foam monitors, proportioner, and valves. The required testing for the foam fire-fighting systems will be carried out using sea water through the foam concentrate pumps without discharging foam.

9.2.9. CO_2 Fire Extingushing Systems

The CO_2 total flooding firefighting system in the machinery spaces and cargo pump room shall be tested in accordance with the CSARB rules and regulations. The system operation test will confirm proper operation of local and remote manual release components for actuation, sirens, time delay devices, and automatic shutdown pressure switches for ventilation fans and damper closure.

Actuation release tests will be conducted for the independent local CO_2 fire extinguishing systems in the following compartments: Emergency Generator Room, Purifier Room, Paint Store, Incinerator Room, Paint and Lamp Store.

9.3. Cargo Systems

Capabilities of all cargo loading, discharging, and ballasting systems will be demonstrated through operational testing.

9.3.1. Cargo Oil System

The cargo oil piping and pumps will be demonstrated to show maximum operational flexibility between pumps and tanks utilizing two suction and two discharge mains. The test will prove functioning of the cargo oil pumps, high voltage motors, cargo stripping pumps, oil content monitor, vacuum priming system, and the cargo oil stripping eductor.

The cargo system centralized control and monitoring system will be demonstrated to the capability of all cargo loading, off-loading, and stripping operations, including pump control and hydraulic control of valves from the main cargo control console. Testing of he automatic self-stripping/priming system connected to each cargo oil pump in the Cargo Pump Room will show proper operation of air separators, vacuum pumps, overflow and drain tanks, all necessary controls and flow regulating valves.

9.3.2. Fixed Tank cleaning System

An operational test of the self draining cargo oil/sea water washing system will be accomplished to ensure adequate cleaning capability of all cargo oil and slop tanks via fixed tank washing machines. Testing of fixed tank cleaning machines will be accomplished using sea water to verify the 0°-180° cleaning arc provided for each cargo oil tank and slop tank. The system operational test will demostrate operation of the Cargo oil/ COW pump, and the tank cleaning steam heater and drain cooler. Portable cleaning machines including hoses, saddles, and reels will be tested using sea water

9.3.3. Segregated Ballast System

A performance test of the entire segregated ballast handling system including operational testing of the associated ballast pumps will be conducted. The performance test will prove that the ballast system and vessel design will permit the complete exchange of ballast water at sea while underway, either by ballast water “replacement” for individual tanks, or, for the forebody tanks, including the forepeak tank, by a continuous “flow through” operation. The system test will prove operation of the ballast piping, pumps, and stripping eductors, and will show maximum flexibility between pumps and tanks through the port and starboard mains and crossover.

9.3.4. Ballast Mud Dispersant System

The ballast water mud treatment system will be operationally demonstrated. The systems chemical storage tank and pump located in the Pump Room access trunk will be run to ensure chemical injection into the ballast water.

9.3.5. Hydraulically Operated Valves

The hydraulic system provided for remote power operation of all ballast system, cargo oil system, inert gas isolation valves will be operationally tested. The system test will include demonstrations of the following hydraulic power pack components: electrically driven hydraulic pumps, filters, accumulators, relief valves, fluid reservoirs, reserve oil tanks, and gauges.

9.4. Deck Machinery

All deck machinery will be tested and operated under maximum load conditions.

9.4.1. Anchor Windlass

The performance tests of the self-contained (integral electro-hydraulic, pre-piped and enclosed) anchor windlasses will include: a no load test to prove direction of rotation and clutch engagement, an operational test to ensure compliance with CSARB requirements, a free fall brake test, and a manual brake test. These tests will be performed dockside prior to sea trials using a test weight to simulate the weight of the anchor chain.

9.4.2. Lifeboat Davits

The lifeboat pivot gravity type davits, winches, sheaves, falls and brakes will be tested in accordance with the CSARB requirements. Testing will include static weight testing of the davits, no-load testing of the winches, and operational testing of the launch and recovery systems including winches, brakes, and safety devices.

9.4.3. Lifeboats

The two totally enclosed, fiberglass, self-righting 40 person lifeboats will be operationally tested to met CSARB requirements. The operational test will include demonstration of the engine, charging system, throttle control, steering control, bilge pump, and emergency tiller. Additionally, the electric battery chargers for each lifeboat will be demonstrated.

9.4.4. Recue Boat Handling Ops

The rescue boat davit, winch, and brakes will be tested in accordance with the CSARB requirements. Testing will include static weight testing of the davits, no-load testing of the winch, and operational testing of the launch and recovery systems including winches, brakes, and safety devices. An operational test of the rescue boat and associated outboard motor, and an inspection of the liferaft installation will also be accomplished.

9.4.5. Cranes: Stores, Hose Handling, and Engine Room Bridge Crane

The two electro-hydraulic stores cranes (5 mTon), the electro-hydraulic cargo hose handling cranes (15,000 Kg), and the electric overhead bridge cranes (7.5 mTons) will be demonstrated to prove compliance with the CSARB requirements. Each crane will undergo a static weight test, no-load operational test, operational weight test, and a test of all safeties and controls including remote controls.

9.4.6. Mooring Winches

The test of mooring equipment will include the performance of all controls, load limiters, brakes, and any other special features. Each mooring winch will be tested at the dock to demonstrate satisfactory operation and compliance with the CSARB rules and performance requirements, including lifting capacity and speed. The performance tests of the self-contained (integral electro-hydraulic, pre-piped and enclosed) mooring winches will include: a no load test, an operational test, a static weight test, an electric brake test, a manual brake test, and a constant tension test. These tests will be performed dockside prior to sea trials.

9.4.7. Personnel Watertight Doors

Personnel Watertight sliding doors between the Steering Gear Rooms and between the Machinery Rooms will be subjected to a water hose test to prove door tightness. The personnel watertight doors will also be operated to demonstrate smoothness of movement and proper functioning of safeties and controls.

9.4.8. Doors Hatches and Scuttles

Doors, hatches, and scuttles will be subjected to the applicable test(s) to prove the doors, hatches, and scuttles to be either watertight, weathertight, airtight, or fumetight.

9.4.9. Accommodation / Pilot Ladders

The two accommodation ladders will be subjected to static weight tests, and the accommodation ladders and winches willondergo an operational demonstration. The demonstration will include a no-load test, and an operational test to prove smooth deployment of the ladder and proper operation of the safeties and limit switches. Additionally, the pilot ladder reel assembly will be statically weight tested, and demonstrated.

9.4.10. Portable and Fixed Davits

The portable lifting davits provided to serve all tank spaces, and the fixed davit installed on Cargo Pump Room housetop will be tested for proper installation, operation, and strength.

9.4.11. Medical, Laundry, and Workshop Equipment

The officer's and crew's laundry equipment will be tested to prove proper installation and operation. Each piece of medical equipment in the hospital shall be operated for a sufficient time to demonstrate satisfactory operation.

The Workshop equipment including: lathes, drill press, grinder, power hacksaw, milling machine, power pipe bender, fuel valve testing equipment, welding equipment, and Electrical Workshop testing equipment, will be tested.

9.5. Hull Equipment

All hull equipment, tanks, and compartments will be demonstrated to ensure CSARB compliance.

9.5.1. Cathodic Protection System

The initial installation checks of the cathodic protection system, and the sea water anti-fouling system will be accomplished as an in-process inspection. The operational tests will be demonstrated during the sea trial.

9.5.2. Tanks and Compartment Tests

Cargo oil tanks, water ballast tanks, structure, and compartments, will be tested in accordance with the CSARB rules using air and water pressure or hose tests as the primary means of testing. Hydrostatic tests, as required by the CSARB, will be conducted. All closures designated as *air tight*, *oil tight*, or *water tight* will be tested in conjunction with the associated compartment or structure in which the closure is installed, or will have a hose test applied. Hatch cover dogging and latching mechanisms will be proven to operate in a satisfactory manner. Remotely operated closures will be demonstrated to operate as specified.

9.5.3. Tank Level Indicators

Calibration of remote reading radar or pressure transducer type tank level indicators for ship's service tanks (ballast, slop, bunkers) and cargo tanks will be demonstrated along with their associated alarm functions. Remote reading temperature indicators and high temperature alarms for each cargo, slop, and bunker tank will also be tested.

9.5.4. Windows

Demonstrations will be accomplished to prove proper operation of wheelhouse front windows fitted with parallel type window wipers, roller blind sun screens, and fresh water cleaning sprayers. In addition, heating elements and clear view screens will be tested where installed.

9.6. Propulsion Systems

All propulsion equipment and associated systems will be functionally tested to prove proper installation and operation.

9.6.1. Propulsion Motors / Reduction Gear

The synchronous, variable speed, high voltage propulsion motors and synchroconverters will be operationally tested along with the reduction gearbox and fixed pitch propeller propulsion shafting arrangement. This demonstration will be accomplished during the overall testing of the propulsion control system. Additionally, the following tests are to be carried out for the propulsion motors:

- Resistance of stator winding (cold) (Manufacturer's test w/shipyard)
- No load test: (Manufacturer's test)
- Locked rotor test: (Manufacturer's test)
- Temperature Test: (Manufacturer's test)
- Fractional Load Test: (Manufacturer's test)
- High Voltage Test: (Manufacturer's test)
- Momentary Overload : (Manufacturer's test)
- Vibration Test: (Manufacturer's test)
- Noise Test: (Manufacturer's test)
- Bearing inspection: (Manufacturer's test w/shipyard)

9.6.2. LO Fill, Transfer, and Purification Systems

The systems provided for filling, transfer, purification and supply of lubricating oil to the main diesel engines, reduction gears, main propulsion motors and main generators will be operationally tested. The piping and pumps will be demonstrated to show maximum operational flexibility between pumps and tanks utilizing manifolds. The test will prove functionality of lubricating oil transfer pumps, duplex type strainers, and LO storage and settling tanks.

Additionally, the lubricating oil purification system provided for main diesel engines and main propulsion reduction gear lubricating systems will be demonstrated. This test will prove proper operation of the partial discharge type purifiers, purifier supply pumps, heaters, automatic temperature control systems, in-line sterilizers, and associated piping systems.

9.6.3. Main Propulsion LO System

Testing of all of the lubricating oil service systems will be in accordance with the respective manufacturer recommendations and requirements. The reduction gear and propulsion shafting arrangement including the attached LO service pumps, independent propulsion motor LO pumps, engine room oil mist detection system, and the independent propulsion reduction gear LO pumps will be operationally tested. Additionally, the MGE LO stand-by pumps, LO sump tanks, LO coolers, self-cleaning strainer, and by-pass strainer will be tested.

9.6.4. Stern Tube System

The system installed to provide seawater or oil lubrication for the stern tube bearings will be tested in accordance with CSARB regulations. The complete

seawater or lube oil supply system will be demonstrated to prove proper operation of stern tube lube oil circulating pumps, or sea water supply pumps, presssure regulating valves, relief valves, and stern tube bearings.

9.6.5. Rudder and Steering Gear

The operation of the hydraulic steering system will be proven at the dock prior to sea trials. The rudder will be checked for smooth movement from port to starboard, and proper response in all operating modes. The system operating pressure will be confirmed, and the relief valve will be checked. The overload alarm and stop alarm test will be demonstrated.

9.7. Accommodations

Balance of all HVAC systems will be demonstrated. Each fan/motor combination will receive an operational run. Proper operation of fire dampers and HVAC controls will be demonstrated. An overall operational air conditioning test will be conducted when the ship is substantially complete.

9.7.1. Galley Equipment

Insulation resistance measurements will be made on all permanently installed electrically operated galley, commissary, and self-contained refrigeration equipment. Operational demonstrations will be conducted to verify equipment performance.

9.7.2. Accommodation Heating Equipment

The proper installation and operation of the heating system and controls, including steam heaters and/or electric heaters will be demonstrated.

9.7.3. Ventilation, Fans and Contols

The installation and operation of the ventilation system fans, associated dampers and controls will be demonstrated. Testing will include insulation resistance tests, operational tests, ventilation balance tests, controls interface and alarms tests. Ventilation fans for machinery spaces, fuel processing rooms, and workshops, and exhaust fans from steering gear, pump room, paint stores, chemical stores, and the anchor windlass machinery room will be demonstrated.

9.7.4. Air Conditioning Plants

The air conditioning plants will be operationally tested to prove proper operation and installation of air conditioning compressors, condensers, safety control devices, and receivers that comprise the packaged air conditioning unit. Testing will include leakage tests, tightness tests, and performance verification tests of system components.

9.7.5. Accommodation Air Conditioning System

Tests will be conducted to prove proper installation and operation of the accommodation air conditioning equipment. Demonstrations will include the centralized medium velocity single duct air handling units and electric reheat system, and the self-contained air conditioning units for the switchboard rooms, and workshops.

9.7.6. Ships Stores Refrigeration Plants

The refrigerated stores plants will be tested to prove proper operation and installation of electric motor driven reciprocating compressors, condensers, and recievers that comprise the ships service refrigeration packaged unit. Testing will include leakage tests, tightness tests, and performance verification tests of system components.

Room unit coolers of the bulkhead or ceiling mounted type including air circulation fans, electric motors, drip pans, expansion valves, solenoid valves, and stop valves will be demonstrated. Other equipment such as electric heaters, timer switches, dryers, strainers, and thermometers will also be tested.

9.8. Auxiliary Systems

9.8.1. Auxiliary Boiler and Services

Hydrostatic testing to meet the requirements of the CSARB will be accomplished after installation onboard. System and onboard operational testing of the combination oil fired/exhaust gas boilers will be performed prior to sea trials. Onboard testing will include operational runs of auxiliary boiler burners, forced draft fans, fuel oil pumps, soot blowers, and photoelectric smoke detectors. A fixed water washing system provided for the exhaust gas section will also be demonstrated.

9.8.2. FO Quick Closing Valves

The proper operation and installation of the FO quick closing valves will be demonstrated. Testing will include operation of the hand pump and relief valves.

9.8.3. Electric Motor Operated Valves (MOV s)

Specified cycling times and control/limit actuation and indicator operation of remotely operated valves will be demonstrated. Motor current will be measured and insulation resistance readings will be taken and recorded.

9.8.4. Distilling Plant

The two flash type distilling units will be operationally tested to prove proper operation utilizing waste heat from the main diesel engines jacket water system, and incorporating a steam supplied heat exchanger as a backup heat source. The test of the system will confirm rated output and quality of distillate, and prove proper operation of the following equipment: evaporator/condenser,

distiller sea water feed pumps, air/brine ejectors, FW distillate transfer pumps, ejector pumps, sea water suction strainers, salinity indicators, flow meters, pressure gauges, and thermometers.

The rate and quality of distilled water production will be recorded. Proper functioning of the salinity measuring equipment, high salinity alarm, high salinity dump, chemical feed treatment, proportioning brominator, and other control features will also be demonstrated to satisfy CSARB requirements. distilled water storage tanks, and distilled water hydropneumatic tanks.

Verification of system alignment between the distilled water tanks, the distilled water transfer pumps, and the boiler cascade tank, central freshwater cooling expansion tanks, high/low temperature freshwater cooling system expansion tanks and other equipment will be demonstrated.

9.8.5. Incinerator

The incinerator shall be operationally tested to prove its ability to burn sludge/waste oil solid waste and plastics. The incinerator fuel system consisting of diesel oil and sludge burners, sludge transfer,pumps and waste oil storage tanks will be demonstrated. The heating coil and associated control valve located in the incinerator sludge tank will also be tested. Testing of the incinerator will include testing of the trash compactor.

9.8.6. Inert Gas System

The inert gas system will be tested for tightness in accordance with the CSARB standards. An operational test shall be performed to verify proper functioning of deck seals, alarms and safety devices, interlocking features, regulating valves, inert gas blowers and pressure relief valves. The automatic combustion control system for the inert gas generator will be tested to confirm proper operation. The inert gas generator fuel pumps, deck seal pumps, and scrubber pump will be operationally tested.

9.8.7. Marine Sanitation Device

The sewage collecting and holding systems including sewage collecting tank, compressor and effluent pump, sewage ejector dishcharge pumps, sewage transfer pump, and the MSD pump will be operationally tested.

9.8.8. Gas Detection System

The hydrocarbon gas sampling scanning systems provided to monitor and alarm all spaces where a build up of flammable gas could potentially occur will be functionally tested. The gas system samples spaces such as: the cargo pump room, fore peak tank, and paint stores. All alarms, shutdowns, air horns, and rotating beacons will also be demonstrated.

9.8.9. Fire Detection System

Fire extinguishing and detection systems will be tested in accordance with the CSARB requirements. Smoke Detectors, heat detectors, alarm boxes, flame detectors, alarm signalling devices, fire and smoke doors and dampers, control panels, sampling systems, stand-by batteries will also be tested.

9.8.10. Misc. Alarm and Warning Systems

Testing will be accomplished to prove proper installation and operation of miscellaneous alarms and warning systems including: Independent high level alarm system, centralized clock system, central bridge alarm, bridge watch monitoring/officer calling alarm system, CO_2 release alarm system, hospital alarm system, and elevator failure alarm system.

9.9. Electric Plant

Power and lighting system (including switchboard and transformer) insulation resistance readings will be taken and recorded. Tests of motors driving auxiliaries will be performed in conjunction with the tests of the driven unit. All electrical and mechanical indicating instruments will have certificate of calibration or be calibrated using suitable standards. The instruments installed in consoles or items of equipment such as radio/radar equipment will, in general, be checked as part of that equipment rather than receiving separate calibration.

9.9.1. Ship Service Generator Operational Test

The Main Diesel Generator (MDG) Engines will be tested along with their constant frequency generators. Additionally, MDG engines and all associated equipment will be subjected to load testing to their rated capacity using load bank equipment in accordance with the CSARB. Generator tests will include: running and parallel operation, voltage and speed regulation, auto synchronizing, auto load sharing, safety and alarm devices, and automatic operations. Dockside testing will be accomplished burning marine diesel oil, and operation on heavy fuel oil will be proven during sea trials.

9.9.2. Emergency Generator Test

The emergency diesel generator and all associated equipment will be load tested to rated capacity using load bank equipment in accordance with the CSARB. Additionally, automatic operation including emergency and feedback modes, and safety and alarm devices shall be demonstrated.

9.9.3. Battery Chargers, Batteries and UPS systems

All battery chargers and UPS systems shall be operationally tested. to verify all modes of control and operation for each unit. Batteries will be operated to ensure minimum performance time requirements.

9.9.4. Switchboard and Circuit Breaker Verification (High Voltage)

An inspection of the HV switchboards and circuit breakers shall be accomblished. Insulation resistance readings will be taken and recorded. Operation and verification of HV circuit breakers and trip units shall be performed.

9.9.5. Lighting System Operational Test

All normal lighting systems will be operationally tested. Emergency lighting will be demonstrated and verified for proper ship coverage. Illumination levels will be calculated and any areas of concern shall be surveyed.

9.10. Interior Communications Equipment

All Builder furnished equipment will be demonstrated to function in accordance with the CSARB rules or equipment specifications. Operation of miscellaneous alarm, indicating and communication systems will be demonstrated. The following equipment, will be demonstrated: automatic exchange telephone, sound powered telephone, public address system, and engineer call system.

9.10.1. Dial Telephone System

The installation and operation of the automatic dial telephone system will be tested. The capability of automatic dial telephone system to be connected to the public address system for announcement through the public address system will be demonstrated.

9.10.2. General alarm and Announcing system

The public address system which integrates the vessel’s fire and general emergency alarm and is capable of providing fog bell and gong signals, public address announcements, and talk back system will be demonstrated.

9.10.3. Entertainment System

The FM/TV and AM radio entertainment distribution system will be demonstrated along with the stabilized direct broadcast satellite TV system.

9.10.4. UHF Internal Communication Systems

The UHF portable transceiver system, together with the associated antenna system will be functionally tested. The system will be proven to sufficiently cover approximately 90 percent of the vessel including: the Machinery Rooms, Steering Gear Rooms, Pump Room, accommodation spaces, Bosun Storeroom and open deck area. Additionally, the UHF portable two-way radios and battery chargers for normal onboard communication use will be demonstrated.

9.10.5. Closed circuit TV System

The color integrated closed circuit TV system for mooring, cargo manifold monitoring, CECR operations, and stack monitoring will be demonstrated. Wash/wipe, pan, tilt, and zoom capabilities of all cameras will be proven.

9.10.6. Shipboard PC Network

Testing of the computer based ship's office network cable for onboard data communications and office functions will be accomplished. The system operational demonstration will prove the structured wiring system provided for all onboard voice and data communications, and the LAN (local area network) cable installed for word processing/games. The various computer based information systems installed by the owner will be tested by the respective vendors.

9.11. Air Compressors and Systems

Air compressors will be given a heat run, controls and safety devices will be demonstrated to comply with regulatory body requirements. The air dryers will be operationally demonstrated.

9.11.1. Starting Air Compressors and System

An operational test of the MDG start air compressors and receivers will prove proper operation of the system. The following components and features will also be demonstrated: automatic starting and stopping functions, automatic unloading and draining functions, oil/water separator operation, safety and control devices, relief valves, and reducing valves. The harbor/emergency generator start air compressors and receivers will be tested in conjunction with the other emergency diesel generator support systems.

9.11.2. Ship Service and Control Air Equipment

The motor driven general service air compressors and receivers will be functionally tested to prove proper installation and operation. Air intake filters and silencers, relief valves, automatic unloaders, self-contained lubricating systems, air dryers, and safety and control devices will be demonstrated.

Additionally, the pressure reducing stations for instrument/control air supplied from the main starting and the general service air systems will be demonstrated. The associated instrument air dehydrators, and filter/regulators which supply air to all pneumatically operated control valves and devices will be tested.

9.11.3. Compressed Air Distribution System

Each general service air outlet for air stations, tool outlets, reducing and regulating valves located throughout the vessel will be operationally tested to ensure proper installation. Filter/moisture separators, pressure gauges, hose valves, and quick disconnect fittings will be demonstrated.

9.12. Navigation And Communications Equipment

The navigation, radar, and radio equipment will be demonstrated to meet the requirements of the regulatory body rules as required for FCC certification. The demonstrations will generally be conducted by the equipment vendor. The radio direction finder and magnetic compass will be calibrated during sea trials.

9.12.1. Navigation and Signal Lights

All signal and navigation lights will be verified for proper location and operation.

9.12.2. Integrated Bridge Electronic Systems

Integrated Bridge Electronic system (IBES) and GMDSS will be demostrated by respective equipment vendors. The IBES will consist of the integrated navigation system and electronic chart display. The GMDSS system will include two INMARSAT standard "C" transceivers, one MF/HF radiotelephone, a radio telex, and DSC.

9.12.3. Radio Communication Equipment

The installation and operation of all radio communication equipment will be demonstrated by respective equipment vendors, including: radio telephone, radio telegraph, V.H.F. telephone, INMARSAT Standard "B". Facilities for commercial communications will include telex, facsimile and a data interface to the ship's office network (Intranet/Internet).

9.12.4. Ships Whistles

The ship's air whistle and electric whistle will be demonstrated to meet CSARB requirements and provide automatic fog signaling. The whistle timer/controller located on the Integrated Navigation System console will also be demonstrated.

9.13. Control System Tests

The centralized engine room and bridge control and monitoring systems will be tested and satisfactory operation will be demonstrated. The Builder will, in association with the manufacturers of all essential and vital control equipment, provide the appropriate periodic test procedures to be followed for CSARB inspections. These test procedures will divide the basic automated controls into two groups; step-by-step procedures, and pass/fail criteria.

9.13.1. MCCS Design Verification Tests

The automated vital systems will be tested to prove that the MCCS is designed to, and operates in accordance with, CSARB requirements. These tests will be based on: Failure Mode Effect Analysis (FMEA), Functional Performance, and Periodic Safety test requirements. The MCCS manufacturer will be responsible for development and demonstration of this test.

9.13.2. MCCS Calibration and Alarms

All alarm setpoints will be verified from field devices to consoles. Calibration of all analog components will be verified at 0, 25, 50, 75 & 100% of scale. All digital alarms shall be demonstrated and setpoints verified.

9.13.3. MCCS Controls and Operation

All controls and status lights shall be verified from their respective stations. Systems will be verified and operated.

9.13.4. MCCS Periodic Test

Periodic safety tests will demonstrate the proper operation of all vital systems. These tests will include: fire detection and extinguishing, flooding safety, propulsion, maneuvering, power generation and distribution, and emergency internal communications.

10. Inclining Experiment

To prove positive stability and determine the GM of the vessel, an inclining experiment will be accomplished on the first of class vessel. The procedure will be approved by the CSARB, and the results will be submitted to the CSARB for approval. The inclining experiment will also include a deadweight survey and will consist of: draft readings, a survey of all dry spaces, a record of tank soundings, and the ship inclining experiment calculations. The procedure for conducting these activities is contained in a separate work instruction document.

11. Dock Trials

When the Vessel is substantially complete a trial will be conducted at the dock to demonstrate the readiness of the propulsion plant with associated auxiliary equipment for Sea Trials. The main propulsion system will be run at such power and for such time, in the ahead and astern directions, as permitted by the mooring. Steering gear, control, and communications systems will be exercised at this time.

12. Sea Trials

When the ship is substantially complete a Sea Trial will be carried out in accordance with the Sea Trial procedure encompassing other tests listed in this section. The Sea Trial will be carried out at ballast and loaded drafts, and in accordance with the requirements of the CSARB. The Sea Trial will include a speed trial, an endurance trial, a maneuvering trial, and other tests as described below.

The following tests and measurements will be conducted at an appropriate time during the sea trials, according to the requirements of the CSARB:

- Unmanned operation test
- Steering gear test
- Shaft torsional vibration measurement at intervals of 5 RPM (1st vessel of class only)
- Hull vibration measurement
- Global vibration at intervals of 5 RPM
- Local vibration at propulsion motor MCR load (during endurance trial)
- Noise measurement at propulsion motor MCR load (during endurance trial)
- Electrical load measurement (during endurance trial)

- Operation test of navigation equipment
- Confirmation of gyro compass and adjustment of the magnetic compass
- Anchoring test
- Black-out test
- Fire detection and alarm test
- Distilling Plant capacity test
- Combined boiler accumulation test
- Cargo pump capacity test
- Ballast pump capacity test
- Inert Gas System Capacity Test
- Emergency Towing Gear Inspection
- Post Trial Inspection

13. Test Procedure Index

Commercial Standard Test Procedure Index				
TP #	TEST PROCEDURE TITLE	WITNESSED BY		
		BUILDER	CUSTOMER	CSARB
MAIN PROPULSION				
8501	PROPULSION SYSTEM MOTORS / RDN GEAR	X	X	X
8503	MACHINERY SEA WATER COOLING	X	X	X
8507	LUBE OIL FILL/ TRANSFER/ PURIFICATION SYSTEMS	X	X	X
8511	MAIN PROPULSION LUBE OIL SYSTEM	X	X	X
8512	STARTING AIR COMPRESSORS AND SYSTEM	X	X	X
8513	SHIP SERVICE AND CONTROL AIR EQUIPMENT	X	X	X
8514	SEGREGATED BALLAST SYSTEM	X	X	X
8515	STEAM & CONDENSATE SYSTEM	X	X	X
8520	FO QUICK CLOSING VALVES	X	X	X
8521	HT/LT FRESH WATER COOLING SYSTEMS	X	X	X
8524	STERN TUBE LUBRICATION SYSTEM	X	X	X

Commercial Standard Test Procedure Index

TP #	TEST PROCEDURE TITLE	WITNESSED BY		
		BUILDER	CUSTOMER	CSARB
	ELECTRICAL			
8604	SHIP SERVICE GEN. OPERATIONAL TESTS	X	X	X
8605	EMERGENCY DIESEL GENERATOR	X	X	X
8607	BATTERIES AND CHARGERS	X	X	X
8613	LIGHTING SYSTEM OPERATION	X	X	X
8617	MCCS DESIGN VERIFICATION TESTS	X	X	
8618	MCCS CALIBRATION AND ALARMS	X	X	X
8619	MCCS CONTROLS AND OPERATION	X	X	X
8621	ELECTRIC MOV'S	X	X	X
8655	NAVIGATION AND SIGNAL LIGHTS	X	X	X
8656	INTEGRATED BRIDGE ELECTRONIC SYSTEMS	X	X	X
8660	DIAL TELEPHONE SYSTEM	X	X	X
8661	SOUND POWERED TELEPHONES	X	X	X
8662	GENERAL ALARM AND ANNOUNCING SYSTEM	X	X	X
8663	ENTERTAINMENT SYSTEM	X	X	X
8664	GAS DETECTION SYSTEM	X	X	X
8665	FIRE DETECTION SYSTEM	X	X	X
8667	MISC. ALARM AND WARNING SYSTEMS	X	X	X
8670	RADIO COMMUNICATION EQUIPMENT	X	X	X
8671	SHIPS WHISTLES	X	X	X
8673	SHIPBOARD PC NETWORK	X	X	X
8674	MCCS PERIODIC TEST	X	X	
8675	UHF INTERNAL COMMUNICATION SYSTEMS	X	X	X
8676	CCTV SYSTEM	X	X	X

Commercial Standard Test Procedure Index

TP #	TEST PROCEDURE TITLE	WITNESSED BY		
		BUILDER	CUSTOMER	CSARB
	AUX SYSTEMS			
8701	TANK LEVEL INDICATORS	X	X	X
8702	PIPING SYSTEMS HYDROSTATIC TESTING	X	X	X
8705	VENTILATION FANS AND CONTROLS	X	X	X
8706	FIRE DAMPERS	X	X	X
8707	VENTILATION SYSTEMS BALANCE	X	X	X
8708	ACCOM HEATING EQUIPMENT	X	X	X
8710	ACCOMMODATION AIR CONDITIONING TEST	X	X	X
8712	A/C PLANTS	X	X	X
8714	SHIPS STORES REFER PLANTS	X	X	X
8715	AUXILIARY BOILER AND SERVICES	X	X	X
8722	MACH'Y BILGE & OILY WASTE TRANSFER SYSTEM	X	X	X
8723	DISTILLING PLANT	X	X	X
8725	POTABLE WATER SYSTEM	X	X	X
8727	FUEL FILL /TRANSFER/ PURIFICATION SYSTEMS	X	X	X
8728	COMPRESSED AIR DISTRIBUTION SYSTEMS	X	X	X
8729	CO2 FIRE EXTINGUISHING SYSTEMS	X	X	X
8730	FIREMAIN AND FOAM SYSTEMS	X	X	X
8732	STEERING GEAR	X	X	X
8735	VCHT SYSTEM	X	X	X
8736	MARINE SANITATION DEVICE	X	X	X
8737	STORES HANDLING CRANES	X	X	X
8738	INCINERATOR	X	X	X
8739	INERT GAS SYSTEM	X	X	X
8740	CARGO OIL SYSTEM	X	X	X
8741	FIXED TANK CLEANING SYSTEM	X	X	X
8742	BALLAST MUD DISPERSANT SYSTEM	X	X	X
8743	HOVs	X	X	X

Commercial Standard Test Procedure Index

TP #	TEST PROCEDURE TITLE	WITNESSED BY		
		BUILDER	CUSTOMER	CSARB
8744	ENGINE ROOM BRIDGE CRANE	X	X	X
DECK				
8805	MOORING WINCHES	X	X	X
8806	LIFEBOAT DAVITS	X	X	X
8807	RESCUE BOAT HANDLING / OPS	X	X	X
8808	LIFEBOATS	X	X	X
8809	ELEVATOR	X	X	X
8810	PERSONNEL WATERTIGHT DOORS	X	X	X
8814	PORTABLE DAVITS	X	X	X
8815	DOORS, HATCHES AND SCUTTLES	X	X	X
8816	CATHODIC PROTECTION SYSTEM	X	X	X
8817	COMMISSARY EQUIPMENT	X	X	X
8819	MEDICAL, LAUNDRY, AND WORKSHOP EQUIPMENT	X	X	X
8826	ANCHOR WINDLASS	X	X	X
8852	SEACHESTS AND OVERBOARDS	X	X	X
8853	TANK AND COMPARTMENT TESTS	X	X	X
8854	WINDOWS	X	X	X
8855	ACCOM/PILOT LADDERS	X	X	X
8856	CRANES, HOSE HANDLING ER BRIDGE, AND STORES	X	X	X

SPECIAL TESTS					
8901	342	NOISE SURVEY	X	X	X
8902	341	INCLINING EXPERIMENT / DEADWEIGHT SURVEY	X	X	X
8920	344	DOCK TRIALS	X	X	X
8930	344	SEA TRIALS	X	X	X

REVISIONS				
REV	DESCRIPTION	DATE	PREP	APPR

DRAWN BY:	TITLE:	
CHECKED BY:	SUPPLEMENTAL TEST AND INSPECTION REQUIREMENTS	
APPROVED BY:	DRAWING NO.: NSRP-0217	REV -
DATE: 8/20/98	SCALE: NONE	SHEET NO. 1 OF 6
NSRP	NATIONAL SHIPBUILDING RESEARCH PROGRAM.	

1 SCOPE

1.1 This standard is approved for use on commercial vessel contracts only.

1.2 This standard addresses test and inspection requirements, and criteria for equipment and systems operational testing during construction, dock trials, and sea trials.

1.3 This standard does not apply to in-process inspection, quality assurance inspections, quality system procedures, process controls, or quality standards applied during the shipbuilding process. Such procedures are a function of the Quality Assurance Department.

1.4 Major items of machinery and equipment, including: main propulsion motors, diesel engines and generators, automation equipment, and selected auxiliaries will also undergo testing at the subcontractor s plant in accordance with the subcontractor s shop testing standards.

2 PURPOSE

2.1 Specific test criteria, expected values and allowable tolerances are identified in each individual test procedure. These criteria and values are generated from system diagrams, engineering input, and vendor technical data. Where test procedures are lacking this information, the supplemental general operational criteria outlined in this standard shall be consulted.

3 GENERAL REQUIREMENTS

3.1 Requirements for test witnessing and notification of test events are addressed in the test plan, and are based on specific customer requirements.

3.2 System operational testing will include demonstration of all local controls and automation. Remote functions which are software driven through the Machinery Centralized Control System (MCCS) will be demonstrated as part of the specific MCCS Test Procedure.

3.3 All testing will be sufficiently documented on the data sheets provided in each individual test procedure.

4 GENERAL OPERATIONAL CRITERIA

4.1 Systems and equipment may be tested in sections as the nature of the system and the shipboard conditions permit. Normal system operating conditions include:

- System filled with operating (or special test) fluid,
- Pump or equipment properly lubricated, and
- System aligned to provide the required flowrate.

4.2 The operational test fluid for pump tests will be in accordance with the following table:

SYSTEM SERVICE FLUID	SYSTEM TEST FLUID
Sea Water	Sea Water or Fresh Water
Fresh Water	Fresh Water
Fuel Oil	Fuel, Diesel Oil, or Safety Solvent
Lubricating Oil	Lubricating Oil, or Safety Solvent
Hydraulic Systems	System Fluid

Bilge/Slops	Sea Water or Fresh Water
Cargo	Sea Water

4.3 When performing operational runs of pumps and compressors, the discharge (or other suitable) valve may be throttled to achieve the design discharge conditions and prevent cavitation. Pumps serving closed loop circulating systems shall be operated at system rated conditions as nearly as possible at the time of the test. It should be noted that some pumping systems will operate at rated conditions only when the ship is operated at sea at power. The sea trial provides opportunity to observe such equipment at rated conditions.

The following table provides allowable variation from design operating pressure for operational and hydrostatic testing. For closed circulating systems, these pressures are considered to be the design differential pressure:

PRESSURE RANGE	**ALLOWABLE VARIATION**
0 to 50 psi	± 3 psi
51 to 100 psi	± 5 psi
101 to 150 psi	± 6 psi
151 psi and over	± 10% of design pressure

5 OPERATING TEMPERATURES

5.1 The temperature of bearings, electrical motor frames, hydraulic oil piping, and other components of the subject test unit shall be observed by touch. When the temperature of a unit is apparently excessive, the temperature shall be taken with a thermometer or other suitable instrument.

5.2 Unless otherwise stipulated by the manufacturer, acceptable machinery component operating temperatures shall be governed by the following:

5.3 Electric Motors

5.3.1 The temperature of the bearings of electric motors shall not exceed the values on the following table:

DESIGNATED MOTOR OPERATING TEMPERATURES	**ALLOWABLE MAXIMUM OPERATING TEMPERATURES**
40° C (104° F)	110° C (230° F)
50° C (122° F)	110° C (230° F)
65° C (149° F)	110° C (230° F)
70° C (158° F)	110° C (230° F)
80° C (176° F)	150° C (302° F)

5.3.2 The maximum temperature of the electric motor frame shall not exceed 50° C (122° F) above ambient, or shall be maintained as specified on the motor nameplate.

5.4 Rotating Machinery (Bearings)

5.4.1 Circulating oil cooled equipment: The temperature of the oil shall not exceed 82°C (180° F), and shall not exceed the outlet oil temperature of the oil cooler by more than 10° C (50° F).

5.4.2 Non-oil cooled pumps: When pumping ambient temperature fluids a maximum of 110° C (230° F) shall not be exceeded. When pumping heated fluids, temperatures listed in the manufacturer's technical manual shall not be exceeded.

5.4.3 Line shaft bearings: Line shaft bearing lube oil sump temperatures shall not exceed 82°C (180° F).

5.5 Hydraulic Systems:

5.5.1 The oil temperature at any point in hydraulic systems shall not exceed 82°C (180° F).

6 MACHINERY OPERATING CHARACTERISTICS: VARIATION TOLERANCES

6.1 The maximum amperage values noted during electric motor operational tests shall not exceed values listed on the motor nameplate, except during start-up and as part of an overload test where applicable.

6.2 Electric motor speed at rated load conditions may vary ±4% of the rated motor speed listed on the motor nameplate.

7 TEMPERATURE INDICATING DEVICES

7.1 If conditions prevent reading installed temperature indicating devices during a test, one of the following procedures shall be used:

7.1.1 Readings shall be taken from the installed thermometers immediately before starting the test, and immediately after stopping the test.

7.1.2 Portable surface mounted temperature indicating devices, with or without remote reading capability may be installed temporarily for use during the test.

8 SENSING DEVICES

8.1 Test Simulators:

8.1.1 Operation of temperature and pressure and other types of sensing devices may be checked by using test simulators.

8.1.2 Test simulators may consist of decade resistance boxes, calibrated power supplies, pressure comparators, calibrated temperature baths, and other devices.

8.1.3 Sensing devices will be demonstrated by applying a precision signal to the sensor and verifying the device calibration or function.

8.1.4 Tolerances for acceptable activation of pressure, temperature, and timed delay switches/control valves shall be as listed in the respective test procedure, or as follows where no other guidelines are given:

PRESSURE SWITCH SETTING	VARIATION TOLERANCES
Low Range 0 to 25 psi	±1 psi
Medium Range 26 to 100 psi	±2 psi
High Range 101 to 300 psi	±3 psi
Over 301 psi	±10% of Pressure Setting

TEMPERATURE SWITCH SETTING	VARIATION TOLERANCES
Low Range 0 to 25°F	±1°F
Medium Range 26 to 100°F	±2°F
High Range 101 to 300°F	±3°F
Over 301°F	±10% of Temperature Setting

Time Delay Switches	±2% of Time Setting

9 INSULATION TESTING

9.1 Insulation resistance measurements shall be taken with a 500VDC megger, except where solid state devices are connected.

9.2 Where circuits contain solid state devices, care should be exercised to ensure that the devices which have a voltage rating less than test voltage are disconnected before the test voltage is applied. If these devices cannot be disconnected, a low voltage ohmmeter shall be used.

9.3 Lighting and Power:

9.3.1 Each lighting and power circuit shall have an insulation resistance between conductors, and between each conductor and ground, of not less than the values listed on the following table:

LOAD RANGE	MINIMUM INSULATION RESISTANCE
Up to 5 Amps	2 MΩ
Up to 10 Amps	1 MΩ
Up to 25 Amps	400,000 Ω
Up to 50 Amps	250,000 Ω
Up to 100 Amps	100,000 Ω
Up to 200 Amps	50,000 Ω
Over 200 Amps	25,000 Ω

9.4 Interior Communication:

9.4.1 Interior communication circuits shall have an insulation resistance between conductors, and between each conductor and ground of not less than the values listed on the following table:

VOLTAGE RANGE	MINIMUM INSULATION RESISTANCE
115V and above	1 MΩ
Below 115V	1/3 MΩ

10 <u>TESTING OF WEIGHT HANDLING FITTINGS AND EQUIPMENT</u>

10.1 Weight handling fittings and equipment will be tested as described by the specific test procedure. Portable hydraulic ram test sets, dynamometer and rigging, certified water weight bags, or certified test weights shall be used to impose test loads.

10.2 Weight handling equipment will be tested in accordance with the applicable classification society and regulatory body requirements.

10.3 Where suspended weights are used to impose the test load, the weight of the handling gear and rigging used (pendants, straps, slings, shackles, turnbuckles, trays, etc.) shall be included in calculating the weight of the applied load.

10.4 Sheaves: For each sheaf associated with the test of weight handling equipment, a frictional component shall be included when calculating the weight of an applied load. The frictional component shall be equal to 2% of the applied load, unless otherwise stated by the manufacturer’s technical data.

11 SAFETY DEVICES

11.1 In the case where certain types of safety devices such as relief valves, temperature switches, etc. are readily removable, it is permissible to remove these items from the system or equipment and bench test them to prove operability.

12 VIBRATION AND NOISE

12.1 Rotating machinery, and other equipment, shall be free of objectionable noise and vibration.

12.2 Where questions regarding a specific unit exist, Test Engineering will evaluate the unit and make a final determination of acceptability of the unit.

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Task 4 - Standard Ship Test Procedures

Project 6-95-1

Prepared For:
William G. Becker
NSRP Program Manager for
Panel SP-6 Marine Industry Standards

Submitted On:
March 9, 1999

By:

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P.O. Box 85278
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Introduction/Abstract

The intent of this project is to investigate and evaluate testing requirements and test criteria as outlined by the Classification Societies and Regulatory Bodies (CSARB), and to develop a mutually agreeable test program which includes a test plan and test procedures. The team has maintained a focus on system testing plans and procedures in an effort to better understand and coordinate the intentions of the CSARB.

Objective

The Test Plan developed for Task 3 is comprised of the documentation, processes, and measures used to effectively test, inspect, and commision a new vessel. The Test Procedures developed for Task 4 identify the requirements set forth by the CSARBs which are used to set-up, start, and demonstrate satisfactory operation of the ship equipment and machinery.

Like the Test Plan, the Test Procedures are based on a medium-sized crude oil tanker. The sample set of Standard Test Procedures developed are *standard* in that they satisfy the all the CSARB requirements. The set of Standard Test Procedures in their current form do not apply to all ship types. To develop a set of Standard Test Procedures that would be suitable for use on all types and sizes of vessels would be impossible.

Approach and Rationale

Through a review of current commercial ship Test Procedures and visits to various shipbuilding facilities the team has developed a set of Test Procedures which represent the current industry trends. The total quantity of Test Procedures has been reduced 25 percent from a traditional U.S. shipyard Test Program.

The format of each individual Test Procedure has been modified to reflect methods used in other countries. Most Test Procedures are comprised primarily of data sheets which identify expected (design) results but do not contain extensive system operational information. Necessary system or equipment operational information is obtained from the associated technical manuals and system diagrams. Test Procedure details outline the test requirements thereby identifying only what is to be demonstrated. The scope of the proposed Test Procedure format has been greatly reduced and does not give detailed descriptions of system set-up or equipment operation (see figure 1). It is up to the individual Test Engineer to determine the most effective method of demonstrating the required system parameters and capabilities. By allowing the Test Engineer the freedom to conduct, coordinate, set-up, and demonstrate the system capabilities testing will be most effectively accomplished.

Sources

Sample Test Procedures evaluated for this exercise include have been obtained from the following shipyards:

- National Steel and Shipbuilding Company
- Newport News Shipbuilding
- Hyundai Heavy Industries
- Avondale Industries
- Kawasaki Heavy Industries
- Other Northern European Shipyards

Results

The set of Standard Test Procedures compiled represents approximately 50 percent of the total quantity of test procedures required for a complete test program. Systems common to most ship types have been selected to present a good cross-section of test requirements, and test procedure development characteristics. The Test Plan submitted in Task 3 lists all the required test procedures for a complete test program.

Test Procedure Format

◆ CURRENT	◆ PROPOSED
– Purpose/Equipment Tested	– Purpose/Equipment Tested
– Times Performed	
– References	– References
– Test Equipment Required	
– Prerequisite Tests	
– Safety and Control Devices	
– Additional Instruction	
– Safety Instruction	
– Test Setup	
– Test Instruction	– Test Instruction
– Data Sheets	– Data Sheets

Figure 1 - Test Procedure Format Comparison

DISCLAIMER

The notice on the front page of each of the ship test procedures is meant only as a prototype of what shipyard personnel might print on their own proprietary test procedures. Permission is hereby granted by the National Shipbuilding Research Program and the Marine Systems Division of the University of Michigan Transportation Research Institute to reproduce, download, and rewrite this material.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE MACHINERY SEAWATER COOLING SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8503		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the machinery sea water cooling system. The operational test of the system will prove proper operation of the following equipment:

1.1 Three (3) sea water cooling pumps

1.2 Two (2) suction strainers

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Seawater Cooling System Diagram, Dwg. No. 7250-342-7109

3 TEST INSTRUCTION

3.1 Align system for normal operation, and operate each pump for 30 minutes to obtain system design conditions. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Demonstrate the ability of the system to take suction from, and discharge to, all branches as indicated on the associated data sheet. Record all operating data, as listed, on data sheets provided.

3.3 Demonstrate proper operation of relief valves, regulating valves, automatic controls, and interlocks. Record all operating data, as listed, on data sheets provided.

Note: The emergency bilge suctions via the seawater system will be demonstrated as part of Test Procedure 8722 - Machinery Bilge and Oily Waste Transfer System

Central Seawater Cooling Pumps Hull Number:______

OPERATIONAL TEST					
Item #	**Description**	**Design**	**Actual**		
			Pump #1	Pump #2	Pump #3
1	**MOTOR**				
	Volts:	440			
	Amps: Phase A	<25			
	Amps: Phase B	<25			
	Amps: Phase C	<25			
	Rotation:	SAT/ UNSAT			
	RPM:	1780			
	Cold Insulation Resistance:	>1MΩ			
	Hot Insulation Resistance:	>1MΩ			
	Bearing Temp:	SAT/ UNSAT			
	Frame Temp:	SAT/ UNSAT			
2	**CONTROLLER**				
	Cold Insulation Resistance:	>1MΩ			
	Hot Insulation Resistance:	>1MΩ			
3	**PUMP**				
	Syst. Design Disch Press:	30 - 40 psi			
	Syst. Design Suct. Press:	0 - 5 psi			
	Bearing Temp:	SAT/ UNSAT			
4	**OBSERVATIONS**				
	Noise:	SAT/ UNSAT			
	Vibration:	SAT/ UNSAT			
	Casing Temp:	SAT/ UNSAT			
	Leakage:	SAT/ UNSAT			
	Lubrication:	SAT/ UNSAT			

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Machinery Seawater Cooling System Hull Number:______

OPERATIONAL TEST					
Item #	**Description**	**Design**	**Actual**		
			Pump #1	Pump #2	Pump #3
5	Pumps start and stop locally	SAT/ UNSAT			
6	Ability to take suction from high and low sea suctions.	SAT/ UNSAT			
7	Ability to discharge to Fresh water cooler and overboard.	SAT/ UNSAT			
8	Prove operation of machinery room cross-connect.	SAT/ UNSAT			

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE LO FILL, TRANSFER, AND PURIFICATION SYSTEM
CHECKED	
APPROVED	DRAWING NUMBER: 461-344- 8507 — REV: DRAFT
DATE	SCALE: NONE — SIZE: A — SHEET 1 OF 6

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the Lube Oil Fill, Transfer, and Purification System. The operational test of the system will prove proper operation of the following equipment:

1.1 Four (4) LO storage tanks

1.2 Two (2) lubricating oil transfer pumps

1.3 Two (2) LO settling tanks

1.4 Two (2) duplex type strainers

1.5 Four (4) partial discharge type purifiers

1.6 Four (4) purifier supply pumps (supplied with purifier package)

1.7 Four (4) heaters (supplied with purifier package)

1.8 Four (4) automatic temperature control systems (supplied with purifier package)

1.9 Four (4) in-line sterilizers (supplied with purifier package)

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Japanese Industrial Standard Number 6601-89

2.5 Lube Oil Fill, Transfer, and Purification System Diagram, Dwg. No. 7250-342-7105

2.6 Lube oil purifier tech manual

3 TEST INSTRUCTION

3.1 Align system for normal operation, and operate each pump for 10 minutes to obtain system design conditions. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Demonstrate proper operation of relief valves, and automatic controls. Record all operating data, as listed, on data sheets provided.

3.3 Demonstrate the piping alignment for filling, transfer, and purification of lubricating oil to the main diesel engines, reduction gears, main propulsion motors and main generators to prove maximum operational flexibility between pumps and tanks utilizing manifolds. Record all operating data, as listed, on data sheets provided.

3.4 Demonstrate operation of LO Purifiers by aligning system for normal operation and allowing purifiers to run for 10 minutes. System alignment may be for batch purification or transfer purification. Record all operating data, as listed, on data sheets provided.

Lubricating Oil Transfer Pumps Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
1	**MOTOR**			
	Volts:	440		
	Amps: Phase A	<15		
	Amps: Phase B	<15		
	Amps: Phase C	<15		
	Rotation:	SAT/ UNSAT		
	RPM:	1780		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
2	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
3	**PUMP**			
	Syst. Design Disch Press:	55 - 65 psi		
	Syst. Design Suct. Press:	0 - 15 psi		
	Relief Valve setting	125 psi (±3 psi)		
	Bearing Temp:	SAT/ UNSAT		
4	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp:	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Lube Oil Purifiers Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			#1	**#2**	**#3**	**#4**
	PURIFIER MOTOR					
	Volts:	440				
	Amps:	<20				
	Rotation:	SAT/ UNSAT				
	RPM:	1800				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
	CONTROLLER					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Manual local START/ STOP Switch	SAT/ UNSAT				
	SUPPLY PUMP					
	Syst. Design Disch Press:	15 - 25 psi				
	Syst. Design Suct. Press:	0 - 5 psi				
	Bearing Temp:	SAT/ UNSAT				
	Relief valve setting	75 psi (±5 psi)				
	PURIFIER					
	Discharge pressure	20 - 35 psi				
	Proper discharge operation	SAT/ UNSAT				
	Bowl RPM	14,000 (± 1400)				
	Alarms And Shutdowns	SAT/ UNSAT				
	HEATER					
	Automatic temp. control systems	160°F (±5°F)				
	Proper operation of in-line sterilizers	SAT/ UNSAT				
	Heater relief valve	75 psi (±5 psi)				
	OBSERVATIONS					
	Unusual Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Overheating:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				

WITNESSED BY:	SHIPBUILDER:	CUSTOMER:	DATE:

LO Purifier Supply Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Pump #1	Pump #2	Pump #3	Pump #4
1	**MOTOR**					
	Volts:	440				
	Amps: Phase A	<12				
	Amps: Phase B	<12				
	Amps: Phase C	<12				
	Rotation:	SAT/ UNSAT				
	RPM:	1760				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
2	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
3	**PUMP**					
	Syst. Design Disch Press:	15 - 25 psi				
	Syst. Design Suct. Press:	5 -10 psi				
	Relief Valve setting	125 psi (±3 psi)				
	Bearing Temp:	SAT/ UNSAT				
4	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

LO Fill, Transfer, and Purification System Hull Number:______

OPERATIONAL TEST			
Line Item #	**Description**	**Design**	**Actual**
	Ability to gravity fill from, and discharge to the Port fill connection	SAT/ UNSAT	
	Ability to gravity fill from, and discharge to the Stbd. fill connection	SAT/ UNSAT	
	Ability to fill and take suction from MDG Engine LO Storage Tank #1	SAT/ UNSAT	
	Ability to fill and take suction from MDG Engine LO Storage Tank #2	SAT/ UNSAT	
	Ability to fill and take suction from MDG Engine LO Settling Tank #1	SAT/ UNSAT	
	Ability to fill and take suction from MDG Engine LO Settling Tank #2	SAT/ UNSAT	
	Ability to fill and take suction from Gen, Motor, & Gear LO Storage Tank #1	SAT/ UNSAT	
	Ability to fill and take suction from Gen, Motor, & Gear LO Storage Tank #2	SAT/ UNSAT	
	Ability of Transfer Pump #1 to take suction from, and pump to associated manifolds	SAT/ UNSAT	
	Manual local START/ STOP Switch operation Transfer Pump #1	SAT/ UNSAT	
	LO Transfer Pump #1 relief valve setting	65 psi (+0/-5 psi)	
	Ability of Transfer Pump #2 to take suction from, and pump to associated manifolds	SAT/ UNSAT	
	Manual local START/ STOP Switch operation Transfer Pump #2	SAT/ UNSAT	
	LO Transfer Pump #2 relief valve setting	65 psi (+0/-5 psi)	
	Ability of LO Purifier #1 to take suction from, and discharge to associated manifolds	SAT/ UNSAT	
	Ability of LO Purifier #2 to take suction from, and discharge to associated manifolds	SAT/ UNSAT	
	Ability of LO Purifier #3 to take suction from, and discharge to associated manifolds	SAT/ UNSAT	
	Ability of LO Purifier #4 to take suction from, and discharge to associated manifolds	SAT/ UNSAT	
	Ability to fill Reduction Gear LO sump #1	SAT/ UNSAT	
	Ability to fill Reduction Gear LO sump #2	SAT/ UNSAT	
	Ability to fill Propulsion motor #1 sump	SAT/ UNSAT	
	Ability to fill Propulsion motor #2 sump	SAT/ UNSAT	
	Ability to fill and take suction from MDG Engine #1 sump	SAT/ UNSAT	
	Ability to fill and take suction from MDG Engine #3 sump	SAT/ UNSAT	
	Ability to fill and take suction from MDG Engine #2 sump	SAT/ UNSAT	
	Ability to fill and take suction from MDG Engine #4 sump	SAT/ UNSAT	
	Ability to fill and take suction from MDG Generator LO sump #1	SAT/ UNSAT	
	Ability to fill and take suction from MDG Generator LO sump #2	SAT/ UNSAT	
	Ability to fill and take suction from MDG Generator LO sump #3	SAT/ UNSAT	
	Ability to fill and take suction from MDG Generator LO sump #4	SAT/ UNSAT	

WITNESSED BY:	SHIPBUILDER:	CUSTOMER:	DATE:

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE MAIN PROPULSION LUBE OIL SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8511		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 5

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the lube oil systems for the main diesel engines, propulsion motors, and reduction gears. The operational test of the system will prove proper operation of the following equipment:

1.1 Four (4) Propulsion motor lube oil pumps

1.2 Two (2) Propulsion reduction gear lube oil pumps

1.3 Four (4) Main diesel engine standby lube oil pumps

1.4 Four (4) Main engine lube oil automatic self-cleaning filters

1.5 Four (4) Three-way temperature control valves

1.6 Four (4) duplex indicator filters

Note: Vendor supplied pumps and directly driven pumps will be tested as part of the associated equipment.

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Lloyd's Register, Classification of Ships Section 5/1.5.1.1

2.5 Main Propulsion Lube Oil System Diagram, Dwg. No. 7250-342-7106

3 TEST INSTRUCTION

3.1 Align each specific lube oil system for normal operation, and operate each pump for 10 minutes to obtain system design conditions. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Demonstrate proper operation of relief valves, temperature control valves, self-cleaning filters, and duplex indicating filters. Record all operating data, as listed, on data sheets provided.

Propulsion Reduction Gear Lube Oil Pumps Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
1	**MOTOR**			
	Volts:	460		
	Amps: Phase A	< 35		
	Amps: Phase B	< 35		
	Amps: Phase C	< 35		
	Rotation:	SAT/ UNSAT		
	RPM:	1800		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
2	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
3	**PUMP**			
	Syst. Design Disch Press:	74 psi		
	Syst. Design Suct. Press:	0-5 psi		
	Relief Valve setting	85 psi (±3 psi)		
	Bearing Temp:	SAT/ UNSAT		
4	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp:	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Main Diesel Generator Standby Lube Oil Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Pump #1	Pump #2	Pump #3	Pump #4
1	**MOTOR**					
	Volts:	460				
	Amps: Phase A	< 50				
	Amps: Phase B	< 50				
	Amps: Phase C	< 50				
	Rotation:	SAT/ UNSAT				
	RPM:	1800				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
2	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
3	**PUMP**					
	Syst. Design Disch Press:	120 psi				
	Syst. Design Suct. Press:	0-5 psi				
	Relief Valve setting	130 psi (±5 psi)				
	Bearing Temp:	SAT/ UNSAT				
4	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				
5	Operation of Automatic Self-Cleaning Filter	SAT/ UNSAT				
6	Operation of duplex indicator filters	SAT/ UNSAT				
7	Operation of three-way temperature control valve	SAT/ UNSAT				

Propulsion Motor Lube Oil Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Pump #1	Pump #2	Pump #3	Pump #4
1	**MOTOR**					
	Volts:	460				
	Amps: Phase A	< 25				
	Amps: Phase B	< 25				
	Amps: Phase C	< 25				
	Rotation:	SAT/ UNSAT				
	RPM:	1800				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
2	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
3	**PUMP**					
	Syst. Design Disch Press:	60 psi				
	Syst. Design Suct. Press:	0-5 psi				
	Relief Valve setting	65 psi (±3 psi)				
	Bearing Temp:	SAT/ UNSAT				
4	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM

1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE STARTING AIR SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8512		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the starting air system. The operational test of the systems will prove proper operation of the following equipment:

1.1 Four (4) Start air compressors

1.2 Two (2) Air Receivers

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.5, and 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/2-52

2.4 Japanese Industrial Standard 0801-89

2.5 Lloyd’s Register, Rules and Regulations, 5/1.5.2

2.6 Main Diesel Generator Starting Air System Diagram, Dwg. No. 7250-342-7112

2.7 Technical Manual for start air compressors

3 TEST INSTRUCTION

3.1 Align the starting air system in a normal configuration, and operate each compressor for for a period of time sufficient to fully charge the associated air flasks. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Verify the operation of the automatic control switches to start, stop, and unload the compressors. Record all operating data, as listed, on data sheets provided.

3.3 Demonstrate proper operation of relief valves, shutdowns, regulating valves, and moisture separators. Record all operating data, as listed, on data sheets provided.

3.4 Verify that start air supply is available to each main diesel generator.

3.5 Alarms, indicators, and software driven controls will be demonstrated on Test Procedure 8619 - MCCS Controls and Operation.

3.6 The required capacity of the MDG starting air system and receivers will be demonstrated during sea trials.

Main Diesel Generator Starting Air Compressors Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Comp #1	Comp #2	Comp #3	Comp #4
1	**MOTOR**					
	Volts:	440				
	Amps: Phase A	<45				
	Amps: Phase B	<45				
	Amps: Phase C	<45				
	Rotation:	SAT/ UNSAT				
	RPM:	1800				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
2	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
3	**COMPRESSOR**					
	Syst. Design Disch Press:	375 psi				
	Bearing Temp:	SAT/ UNSAT				
4	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Main Diesel Generator Starting Air System Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Port		Starboard	
			Comp #2	Comp #4	Comp #1	Comp #3
5	MDG start air compressors start and stop locally.	SAT/ UNSAT				
6	Lube oil low pressure cut out setting	14 psig				
7	High gas temperature cut-out	225°F				
8	Lead compressor cut-in pressure controls	362 psig ± 5 psig				
9	Standby compressor cut-in pressure controls	334 psig ± 5 psig				
10	Lead compressor cut-out pressure controls	400 psig ± 5 psig				
11	Stby compressor cut-out pressure controls	400 psig ± 5 psig				
12	Unloading system operation	SAT/ UNSAT				
13	Proper operation of moisture separators	SAT/ UNSAT				
14	MDG start air receiver relief valve setting	425 psig +0/-5 psi				
			MDG #2	MDG #4	MDG #1	MDG #3
15	Start air supply available at MDG	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE SHIP SERVICE AND CONTROL AIR SYSTEM	
CHECKED		
APPROVED	DRAWING NUMBER	REV
	461-344- 8513	DRAFT
DATE	SCALE: NONE / SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the general service air system. The operational test of the systems will prove proper operation of the following equipment:

1.1 Two (2) General Service Air Compressors

1.2 Two (2) General Service Air Receivers

1.3 Two (2) General Service Air Dryers

1.4 Six (6) Pressure Reducing Stations

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification Sect. M-5.6.3

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Lloyd’s Register, Rules and Regulations, 5/1.5.1.1

2.5 General Service and Control Air System Diagram, Dwg. No. 461-342-7118

2.6 Technical Manual for general service air compressors.

3 TEST INSTRUCTION

3.1 Align the general service air system in a normal configuration, and operate each compressor for for a period of time sufficient to fully charge the associated air receivers. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Verify the operation of the automatic control switches to start, stop, and unload the compressors. Record all operating data, as listed, on data sheets provided.

3.3 Demonstrate proper operation of relief valves, shutdowns, regulating valves, and moisture separators. Record all operating data, as listed, on data sheets provided.

3.4 Verify that service air supply is available at the outlet of each general service air dryer.

3.5 Alarms, indicators, and software driven controls are demonstrated on Test Procedure 8618, MCCS Calibration and Alarms.

3.6 Air distribution system piping and associated equipment is tested on Test Procedure 8728, Compressed Air Distribution Systems.

General Service Air Compressors Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Comp #1	Comp # 2
1	**MOTOR**			
	Volts:	460 (±23 Volts)		
	Amps: Phase A	65 Max.		
	Amps: Phase B	65 Max.		
	Amps: Phase C	65 Max.		
	Rotation:	SAT/ UNSAT		
	RPM:	1780 (±70 RPM)		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
2	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
3	**COMPRESSOR**			
	Syst. Design Disch Press:	115 psi (±6 psig)		
	Bearing Temp:	SAT/ UNSAT		
4	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp:	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

General Service Air System Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Starboard Comp #1	Port Comp #2
5	General Service air compressors start and stop locally.	SAT/ UNSAT		
6	Lube oil low pressure cut out setting	14 psig (±1 psig)		
7	High gas temperature cut-out	140°F (±3°F)		
8	Compressor cut-in pressure controls	100 psig (± 5 psig)		
11	Compressor cut-out pressure controls	125 psig (± 5 psig)		
12	Unloading system operation	SAT/ UNSAT		
13	Proper operation of moisture separators	SAT/ UNSAT		
14	Proper operation of pressure reducer - Emergency supply to general service air system from main starting air system	87 psig (± 5 psig)		
15	Proper operation of pressure reducer - Emergency supply to instrument air from general service air system from starting air system.	50 psig (± 3 psig)		
16	Proper operation of pressure reducer - Supply to instrument air system from main starting air system.	50 psig (± 3 psig)		
17	General Service air receiver relief valve setting	140 psig (+0/-5 psi)		
18	General Service air supply available at dehydrator outlet	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM

1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE SEGREGATED BALLAST SYSTEM	
CHECKED		
APPROVED	DRAWING NUMBER	REV
	461-344- 8514	DRAFT
DATE	SCALE: NONE / SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
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1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the Segregated Ballast System. The operational test of the system will prove proper operation of the following equipment:

1.1 Two (2) ballast pumps

1.2 Two (2) ballast stripping eductors

1.3 Ballast water mud treatment system including two (2) injection pumps

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Lloyd’s Register, Classification of Ships, Part 5/1.5.1.1

2.5 Segregated Ballast System Diagram, Dwg. No. 7250-342-7116

2.6 Ballast water treatment system tech manual

3 TEST INSTRUCTION

3.1 Align system for normal operation, and demonstrate the systems ability for ballasting, and deballasting of sea water to and from the water ballast tanks. Verification of water transfer can be confirmed by tank level indicators, direct observation of flow in tank, or by sounding tape. Record all operating data, as listed, on data sheets provided.

3.2 During operation of system, record all pump operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.3 Demonstrate proper operation of the ballast water mud treatment system, including operation of the associated injection pumps.

3.4 Demonstrate proper operation of relief valves, and automatic controls. Record all operating data, as listed, on data sheets provided.

3.5 Align the fire pumps to supply water to the ballast stripping eductors and demonstrate the eductors’ ability to take suction from the farthest (forepeak) tank. Record results, as listed, on data sheets provided.

3.6 The ability of the port fire pump to deballast the aft peak tank will be demonstrated as part of the Fire and Foam System Test Procedure.

3.7 The 24 inch emergency deballast connection to the cargo system will be demonstrated as part of the Cargo Oil System Test Procedure.

Ballast Pumps Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Stbd Pump (#1)	Port Pump (#2)
1	**MOTOR**			
	Volts:	460		
	Amps: Phase A	<22		
	Amps: Phase B	<22		
	Amps: Phase C	<22		
	Rotation:	SAT/ UNSAT		
	RPM:	1780		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
2	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
3	**PUMP**			
	Syst. Design Disch Press:	150 psi		
	Syst. Design Suct. Press:	27” vac - 15 psi		
	Relief Valve setting	psi (±3 psi)		
	Bearing Temp:	SAT/ UNSAT		
4	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp:	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Segregated Ballast System Hull Number:______

OPERATIONAL TEST				
Line Item #	**Description**	**Design**	**Suction**	**Disch.**
	Ability to pump to, and disch from the following tanks:			
	Forepeak Ballast Tank	SAT/ UNSAT		
	No. 1 Water Ballast J Tank Port	SAT/ UNSAT		
	No. 2 Water Ballast J Tank Port	SAT/ UNSAT		
	No. 3 Water Ballast J Tank Port	SAT/ UNSAT		
	No. 3 Water Ballast U Tank Port	SAT/ UNSAT		
	No. 4 Water Ballast J Tank Port	SAT/ UNSAT		
	No. 5 Water Ballast J Tank Port	SAT/ UNSAT		
	No. 6 Water Ballast J Tank Port	SAT/ UNSAT		
	No. 1 Water Ballast J Tank Starboard	SAT/ UNSAT		
	No. 2 Water Ballast J Tank Starboard	SAT/ UNSAT		
	No. 3 Water Ballast J Tank Starboard	SAT/ UNSAT		
	No. 3 Water Ballast U Tank Starboard	SAT/ UNSAT		
	No. 4 Water Ballast J Tank Starboard	SAT/ UNSAT		
	No. 5 Water Ballast J Tank Starboard	SAT/ UNSAT		
	No. 6 Water Ballast J Tank Starboard	SAT/ UNSAT		
			Port	**Stbd**
	Manual local START/ STOP switch operation Ballast Pump	SAT/ UNSAT		
	Ballast Pump relief valve setting	65 psi (+0/-5 psi)		
	Ability of ballast stripping eductor to take dishcharge from forepeak tank	SAT/ UNSAT		
	Proper operation of ballast water mud treatment system (2 injection pumps)	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE STEAM AND CONDENSATE SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8515		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the steam and condensate system. The operational test of the systems will prove proper operation of the following equipment:

1.1 Relief valves

1.2 Temperature control valves

1.3 Pressure reducing valves

1.4 Pneumatic control valves

1.5 Steam drains coolers

1.6 Boiler feedwater salinity indicator system

1.7 Contaminated drains tanks

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.2, 4/6.7.8.

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Lloyd's Register, Classification of Ships, 5/12.7.2, 5/1.5.1.1.

2.5 Condensate and Contaminated Drains System Diagram, Dwg. No. 7250-342-7123

2.6 Auxiliary Steam Services Diagram, Dwg. No. 7250-342-7124

2.7 Combination Boiler Feedwater System Diagram, Dwg. No. 7250-342-7120

3 TEST INSTRUCTION

3.1 For the following tests, flow verification can be made by means of local gages, rise in temperature of piping, or blowdown from equipment steam trap.

3.2 With the auxiliary boiler secured, connect shore steam hoses and verify steam and condensate flow through the equipment listed on the data sheets. Record all data on sheets provided

3.3 With the auxilary boiler on line, prove proper steam and condensate flow through equipment as indicated on data sheets. Record all data on sheets provided.

3.4 Verify condensate flow through the equipment as listed on the data sheets. Record all data on sheets provided

3.5 Verify that each relief valve lifts at the setpoint listed on the data sheet. Record all data on sheets provided

3.6 Demonstrate the operation of each temperature control valve. Record all data on sheets provided

3.7 Demonstrate the operation of each pressure reducing valve. Record all data on sheets provided

3.8 Demonstrate the operation of the boiler feedwater salinity indicating system. Record all data on sheets provided

3.9 The auxiliary boiler safety valves, and the auxiliary steam dump backpressure valve are tested as part of the Auxiliary Boiler Test Procedure.

Steam and Condensate System Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
1	Verify shore steam / condensate flow through the following:					
	TBD	SAT/UNS				
	TBD	SAT/UNS				
	TBD	SAT/UNS				
2	Verify steam / condensate flow through:					
	EDG room heater	SAT/UNS				
	Upper deck workshop heater	SAT/UNS				
	Engineer's/electrical workshop	SAT/UNS				
	Paint and lamp store room heater	SAT/UNS				
	Inert gas deck water seal	SAT/UNS				
	Low sulfer heavy fuel oil settling tank	SAT/UNS				
	Low sulfer heavy fuel oil storage tank	SAT/UNS				
	Heavy fuel oil settling tank	SAT/UNS				
	Incinerator sludge tank	SAT/UNS				
	Heavy fual oil sludge tank	SAT/UNS				
	Lube oil sludge tank	SAT/UNS				
			Port (#2)		**Starboard (#1)**	
	MDG jacket water /distilling plant heater	SAT/UNS				
	Air handling unit pre-heater (house)	SAT/UNS				
	Steering gear room heater	SAT/UNS				
	Cascade tank steam injection	SAT/UNS				
	Heavy fuel oil purifier heater	SAT/UNS				
	Boiler fuel oil heater	SAT/UNS				
	Low sulfer heavy fuel oil service tanks	SAT/UNS				
	Heavy fuel oil service tanks	SAT/UNS				
	Heavy fuel oil overflow tank	SAT/UNS				
	MDG Lube oil settling tank	SAT/UNS				
	Bilge water holding tanks	SAT/UNS				
	Waste oil tanks	SAT/UNS				
	Slop tanks	SAT/UNS				
			#2	**#4**	**#1**	**#3**
	Lube oil purifier heater	SAT/UNS				
	MDG fuel oil heater	SAT/UNS				
	Heavy fuel oil storage tanks	SAT/UNS				
	Lube oil sump	SAT/UNS				

3	Verify condensate flow through:			
	Contaminated drains cooler	SAT/UNS		
	Combined Atmospheric dump condenser/clean drains cooler	SAT/UNS		
	Misc. contaminated drain inspection tank	SAT/UNS		
	Cargo contaminated drain inspection tank	SAT/UNS		
4	Operation of relief valves			
	Blr #1 Fd Pump Discharge	600 psi ±30		
	Blr #2 Fd Pump Discharge	600 psi ±30		
	Chemical dosing pump	120 psi ±7		
5	Operation of temperature regulating valves			
	Maintains Blr #1 Temp	340°F		
	Maintains Blr #1 Temp	340°F		
	Maintains Feed water Temp	340°F		
6	Operation of pressure reducing valves			
	100 psi to 85 psi	SAT/UNS		
	100 psi to 35 psi	SAT/UNS		
	100 psi to 60 psi	SAT/UNS		
7	Operation of boiler feedwater salinty indicating system	SAT/UNS		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE FUEL OIL SERVICE SYSTEM			
CHECKED				
APPROVED	DRAWING NUMBER			REV
DATE	461-344- 8519			DRAFT
	SCALE: NONE	SIZE: A	SHEET 1 OF 6	

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the Fuel Oil Service System. The operational test of the system will prove proper operation of the following equipment:

1.1 Four (4) MDE fuel oil circulating pumps (supplied with HFO unit)

1.2 Two (2) Diesel oil circulating pumps

1.3 Two (2) DO filters (automatic, self-cleaning)

1.4 Four (4) MDE fuel oil supply pumps (supplied with HFO unit)

1.5 Four (4) MDE fuel oil supply pump strainers (supplied with HFO unit)

1.6 Four (4) Fuel oil heaters (supplied with HFO unit)

1.7 Four (4) Viscosity control systems (supplied with HFO unit)

1.8 Two (2) Fuel oil meters (supplied with HFO unit)

1.9 Two (2) Full flow fuel oil filters (automatic, self-cleaning, supplied with HFO unit)

1.10 Two (2) Fuel oil bypass strainers (supplied with HFO unit)

1.11 Two (2) LSHFO service tank

1.12 Two (2) HFO service tanks

1.13 One (1) MDO service tank

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.4, 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Lloyd’s Register, Classification of Ships, section 5/1.5.1.1

2.5 Japanese Industrial Standard Number 6602-79

2.6 Main Diesel Generator Fuel Oil & Diesel Oil Service System Diagram, Dwg. No. 7250-342-7115

2.7 Heavy fuel oil unit tech manual

3 TEST INSTRUCTION

3.1 Align Fuel Oil service system for normal operation, and operate each pump for 10 minutes to obtain system design conditions. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Demonstrate proper operation of relief valves, and automatic controls. Record all operating data, as listed, on data sheets provided.

3.3 Align the DO circulating pump for normal operation and run the pump for a sufficient length of time to record operating data as listed on data sheet.

3.4 Demonstrate operation of FO heaters, viscosity controllers, and automatic filters IAW Reference 2.7 by aligning system for normal operation. Record all operating data, as listed, on data sheets provided.

MDE Fuel Oil Supply Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Pump #1	Pump #2	Pump #3	Pump #4
1	**MOTOR**					
	Volts:	460				
	Amps: Phase A	< 20				
	Amps: Phase B	< 20				
	Amps: Phase C	< 20				
	Rotation:	SAT/ UNSAT				
	RPM:	1760				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
2	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
3	**PUMP**					
	Syst. Design Disch Press:	100 psi				
	Syst. Design Suct. Press:	0 - 10 psi				
	Relief Valve setting	125 psi (±5 psi)				
	Bearing Temp:	SAT/ UNSAT				
4	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				
	Operation of duplex strainer	SAT/ UNSAT				

MDE Fuel Oil Circulating Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Pump #1	Pump #2	Pump #3	Pump #4
5	**MOTOR**					
	Volts:	460				
	Amps: Phase A	< 20				
	Amps: Phase B	< 20				
	Amps: Phase C	< 20				
	Rotation:	SAT/ UNSAT				
	RPM:	1760				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
6	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
7	**PUMP**					
	Syst. Design Disch Press:	100 psi				
	Syst. Design Suct. Press:	0 - 10 psi				
	Relief Valve setting	125 psi (±5 psi)				
	Bearing Temp:	SAT/ UNSAT				
8	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				
	Operation of duplex strainer	SAT/ UNSAT				

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
9	**MOTOR**			
	Volts:	460		
	Amps: Phase A	< 8		
	Amps: Phase B	< 8		
	Amps: Phase C	< 8		
	Rotation:	SAT/ UNSAT		
	RPM:	1760		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
10	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
11	**PUMP**			
	Syst. Design Disch Press:	100		
	Syst. Design Suct. Press:	0 - 10 psi		
	Relief Valve setting	125 psi (±5 psi)		
	Bearing Temp:	SAT/ UNSAT		
12	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp:	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		
	Operation of duplex strainer	SAT/ UNSAT		

Fuel Oil Service System Hull Number:______

OPERATIONAL TEST						
Line Item #	**Description**	**Design**	**Actual**			
			Unit #1		Unit #2	
13	Proper operation of diesel oil automatic self-cleaning filters	SAT/ UNSAT				
14	Proper operation of fuel oil meters	SAT/ UNSAT				
15	Proper operation of fuel oil automatic self-cleaning filters	SAT/ UNSAT				
16	Proper operation of fuel oil bypass strainers	SAT/ UNSAT				
			#1	#2	#3	#4
17	Proper operation of MDE fuel oil supply pump strainers	SAT/ UNSAT				
18	Proper operation of MDE fuel oil heaters	SAT/ UNSAT				
19	Proper operation of MDE fuel oil viscosity units	SAT/ UNSAT				

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE FUEL OIL QUICK CLOSING VALVES	
CHECKED		
APPROVED	DRAWING NUMBER: 461-344- 8520	REV: DRAFT
DATE	SCALE: NONE / SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the hydraulically actuated quick closing valves. The operational test of the system will prove proper operation of the following equipment:

1.1 One (1) Quick closing valve control panel

1.2 One (1) Control panel relief valve

1.3 Twenty-eight (28) Quick closing valves

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section M-5.5

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels Part 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-41,42

2.4 Lloyd’s Register, Classification of Ships, Part 5/1.5.1.1

2.5 Japanese Industrial Standard 7457-89

2.6 FO and DO Service System Diagram, Dwg. No. 7250-342-7115 Rev. -

2.7 FO and DO Fill, Transfer, and Purification Diagram, Dwg. No. 7250-342-7114 Rev. -

2.8 Hydraulical Piping Systems Diagram, Dwg. No. 7250-342-7128 Rev. -

2.9 Tech Manual - Hydraulically operated quick closing valves and control panel.

3 TEST INSTRUCTION

3.1 Ensure the hydraulic actuation system is filled and vented, and align the for normal operation. Demonstrate the ability of each quick closing valve. Record all operating data, as listed, on data sheets provided.

3.2 Demonstrate the operation of the relief valve located on the control panel. Record data, as appropriate, on data sheets provided.

FO TANK QUICK CLOSING VALVES OPERATIONAL TEST			Hull Number:______
Item #	**Description**	**Design**	**Actual**
1	**HFO TANK QUICK CLOSING VALVES**		
	HFO Storage Tank #1	Closes < 6 strokes of hand pump	
	HFO Storage Tank #2	Closes < 6 strokes of hand pump	
	HFO Storage Tank #3	Closes < 6 strokes of hand pump	
	HFO Storage Tank #4	Closes < 6 strokes of hand pump	
	HFO Settling Tank	Closes < 6 strokes of hand pump	
	HFO Service Tank #1	Closes < 6 strokes of hand pump	
	HFO Service Tank #2	Closes < 6 strokes of hand pump	
	HFO Overflow Tank #1	Closes < 6 strokes of hand pump	
	HFO Overflow Tank #2	Closes < 6 strokes of hand pump	
2	**LSHFO TANK QUICK CLOSING VALVES**		
	LSHFO Storage Tank	Closes < 6 strokes of hand pump	
	LSHFO Settling Tank	Closes < 6 strokes of hand pump	
	LSHFO Service Tank #1	Closes < 6 strokes of hand pump	
	LSHFO Service Tank #2	Closes < 6 strokes of hand pump	
3	**MDO TANK QUICK CLOSING VALVES**		
	MDO Storage Tank	Closes < 6 strokes of hand pump	
	MDO Service Tank	Closes < 6 strokes of hand pump	
4	**LO TANK QUICK CLOSING VALVES**		
	Gen, Gear, & Motor, LO Storage Tank #1	Closes < 6 strokes of hand pump	
	Gen, Gear, & Motor, LO Storage Tank #2	Closes < 6 strokes of hand pump	
	Gen, Gear, & Motor, LO Settling Tank #1	Closes < 6 strokes of hand pump	
	Gen, Gear, & Motor, LO Settling Tank #2	Closes < 6 strokes of hand pump	
	MDG LO Storage Tank #1	Closes < 6 strokes of hand pump	
	MDG LO Storage Tank #2	Closes < 6 strokes of hand pump	
	MDG LO Settling Tank #1	Closes < 6 strokes of hand pump	
	MDG Settling Tank #2	Closes < 6 strokes of hand pump	

FO TANK QUICK CLOSING VALVES OPERATIONAL TEST			Hull Number:______
Item #	**Description**	**Design**	**Actual**
5	**MISC. TANK QUICK CLOSING VALVES**		
	Waste Oil tank	Closes < 6 strokes of hand pump	
	Sludge Tank	Closes < 6 strokes of hand pump	
	Incinerator MDO Tank	Closes < 6 strokes of hand pump	
	EDG MGO Tank	Closes < 6 strokes of hand pump	
	Inert Gas Generator MDO Tank	Closes < 6 strokes of hand pump	
6	Relief valve set point	250 psig +0/-7 psig	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE HIGH TEMPERATURE & LOW TEMPERATURE FRESH WATER COOLING SYSTEMS		
CHECKED			
APPROVED	DRAWING NUMBER		REV
DATE	461-344- 8521		DRAFT
	SCALE: NONE	SIZE: A	SHEET 1 OF 7

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the high temperature and low temperature fresh water cooling systems. The operational test of the systems will prove proper operation of the following equipment:

1.1 Four (4) MDG jacket water cooling pumps

1.2 Four (4) Central fresh water cooling pumps

1.3 Two (2) Distilled water transfer pumps

1.4 Two (2) chemical dosing systems

1.5 Two (2) jacket water cooling system expansion tanks

1.6 Two (2) fresh water cooling system expansion tanks

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Low Temperature Fresh Water Cooling System Diagram, Dwg. No. 7250-342-7107

2.5 High Temperature Fresh Water Cooling System Diagram, Dwg. No. 7250-342-7108

3 TEST INSTRUCTION

3.1 Align high temperature fresh water cooling system in a normal configuration, and operate each pump for 30 minutes. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets. Prove flow through equipment as indicated on data sheets.

3.2 Align low temperature fresh water cooling system in a normal configuration, and operate each pump for 30 minutes. Record all operating data, as listed, on data sheets provided. Prove flow through equipment as indicated on data sheets.

3.3 Demonstrate proper operation of relief valves, regulating valves, automatic controls, and interlocks. Record all operating data, as listed, on data sheets provided.

Main Diesel Generator Jacket Water Cooling Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Pump #1	Pump #2	Pump #3	Pump #4
1	**MOTOR**					
	Volts:	460				
	Amps: Phase A	<21				
	Amps: Phase B	<21				
	Amps: Phase C	<21				
	Rotation:	SAT/ UNSAT				
	RPM:	1780				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
2	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
3	**PUMP**					
	Syst. Design Disch Press:	30 - 40 psi				
	Syst. Design Suct. Press:	0 - 5 psi				
	Bearing Temp:	SAT/ UNSAT				
4	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Central Fresh Water Cooling Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Pump #1	Pump #2	Pump #3	Pump #4
5	**MOTOR**					
	Volts:	460				
	Amps: Phase A	<25				
	Amps: Phase B	<25				
	Amps: Phase C	<25				
	Rotation:	SAT/ UNSAT				
	RPM:	1780				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
6	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
7	**PUMP**					
	Syst. Design Disch Press:	30 - 40 psi				
	Syst. Design Suct. Press:	0 - 5 psi				
	Bearing Temp:	SAT/ UNSAT				
8	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Distilled Water Transfer Pumps Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
9	**MOTOR**			
	Volts:	460		
	Amps: Phase A	<15		
	Amps: Phase B	<15		
	Amps: Phase C	<15		
	Rotation:	SAT/ UNSAT		
	RPM:	1800		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
10	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
11	**PUMP**			
	Syst. Design Disch Press:	30 - 40 psi		
	Syst. Design Suct. Press:	0 - 5 psi		
	Bearing Temp:	SAT/ UNSAT		
12	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp:	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

High Temperature Fresh Water Cooling System Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Port		Starboard	
			Pump #1	Pump #2	Pump #3	Pump #4
13	MDG jacket cooling pumps start and stop locally.	SAT/ UNSAT				
14	Verify flow through:					
	Jacket water steam heater	SAT/ UNSAT				
	Fresh water generator	SAT/ UNSAT				
	MDG jacket water cooler	SAT/ UNSAT				
	Nozzle cooling water cooler	SAT/ UNSAT				
	MDG cylinder cooling & charge air cooler (HT circuit)	SAT/ UNSAT				
15	Operation of temperature regulating valve	SAT/ UNSAT				
16	Ability to fill jacket water cooling system expansion tank from fresh water drain tank	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Low Temperature Fresh Water Cooling System Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Port		Starboard	
			Pump #1	Pump #2	Pump #3	Pump #4
17	Central fresh water cooling pumps start and stop locally.	SAT/ UNSAT				
18	Verify flow through:					
	Central fresh water cooler					
	MDG engine jacket water cooler					
	MDG charge air cooler					
	MDG lube oil cooler					
	MDG air cooler					
	Start air compressor cooler					
	Propulsion motor cooler					
	Reduction gear LO cooler					
	COW pump motor air cooler					
	Refrigerated stores condensers					
	A/C Plants					
	Cargo pump motor air cooler					
	Med. voltage switch room A/C unit					
	Workshop A/C unit					
	Contaminated drain cooler					
	Combined atom. dump cond/clean drains cooler					
	Transformer cooler					
	Synchro-converter cooler					
19	Operation of temperature control valve	SAT/ UNSAT				
20	Ability to fill central fresh water cooling system expansion tankfrom distilled water transfer pump	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE STERN TUBE SEAWATER COOLING / LUBRICATION SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8524		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the stern tube sea water cooling and lubrication system. The operational test of the system will prove proper operation of the following equipment:

1.1 Four (4) sea water circulating pumps

1.2 Two (2) suction strainers

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Stern Tube Seawater Cooling/Lubrication System Diagram, Dwg. No. 7250-342-7129

3 TEST INSTRUCTION

3.1 Align system for normal operation, and operate each pump for 30 minutes to obtain system design conditions. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Demonstrate proper operation of relief valves, regulating valves, automatic controls, and interlocks. Record all operating data, as listed, on data sheets provided.

Stern Tube Seawater Circulating Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Port		**Starboard**	
			Pump #2	Pump #4	Pump #1	Pump #3
1	**MOTOR**					
	Volts:	460				
	Amps: Phase A	<.8				
	Amps: Phase B	<.8				
	Amps: Phase C	<.8				
	Rotation:	SAT/ UNSAT				
	RPM:	1200				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
2	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
3	**PUMP**					
	Pumps start and stop locally	SAT/ UNSAT				
	Syst. Design Disch Press:	2.5 bar				
	Syst. Design Suct. Press:	.3 bar				
	Bearing Temp:	SAT/ UNSAT				
4	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				

Stern Tube Seawater Cooling/Lubrication System Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Port	**Starboard**
6	Operation of self-cleaning filter	SAT/ UNSAT		
7	Operation of controlled by-pass	SAT/ UNSAT		
8	Operation of Emergency dump to bilge	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN

CHECKED

APPROVED

DATE

TITLE:

TEST PROCEDURE
MAIN DIESEL GENERATORS

DRAWING NUMBER	REV
461-344- 8604	DRAFT

SCALE: NONE | SIZE: A | SHEET 1 OF 21

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the Ship's Main Diesel Generators. The operational test of the system will prove proper operation of the following equipment:

1.1 Four (4) 6,300KW, 6.6KV, Diesel Generator sets and associated systems

1.2 Four (4) Diesel pre-lube oil pumps

1.3 Eight (8) Generator pre-lube oil pumps

1.4 Four (4) Turning gears

Note: Parallel operation of generators, power management systems and HFO units will be operationally tested during sea trials.

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, Section E-3.0

2.2 46 Code of Federal Regulations, Sections 111.12-1 to 12.7

2.3 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Sections 4/5.21.1, 4/5C2.3

2.4 IEEE Recommended Practice for Electric Installations on Shipboard, Std 45-15, 46.2.2

2.5 Japanese Industrial Standard 8072-86

2.6 International Electrotechnical Commission, Part 92-401/11/60

2.7 Lloyd's Register, Classification of Ships, Part 6/2/20.2.4

2.8 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E200 to 202

2.9 Tech Manual – Main Diesel Generator – (Diesel)

2.10 Tech Manual – Main Diesel Generator – (Generator)

2.11 Tech Manual – High Voltage Switchboard

3 TEST INSTRUCTION

3.1 Align the diesel generator electrical power plant as necessary to perform the following test requirements. It should be noted that the system, which includes the diesel generators with local control panels, operating panels located in ECR, control sections located on the high voltage switchboards, and the high voltage switchboards, will not necessarily be in a normal operating condition during these tests.

3.2 **Operational Tests of Auxiliary Equipment -** Demonstrate proper operation of the following auxiliary equipment: Main Diesel Engine Fuel Booster pumps, Turning Gears, Pre-Lube Oil pumps and Generator Pre-Lube Oil pumps. During operation of each system, record all pump/motor operating data, as listed, on data sheet provided. Design data not shown on the data sheet shall be obtained from subject equipment nameplate data, and entered on the data sheet.

3.3 **Operational Test -** Prove proper operation of local and manual controls associated with the main diesel generator's safety and alarm systems IAW references 2.9 through 2.10. Record all data, as listed, on data sheets provided.

3.4 **Operational Test -** Demonstrate proper operation of oil mist detectors and generator heaters. Record all data, as listed, on data sheets provided.

3.5 **Load Test** Prior to load test, perform cold megger readings before start-up of diesel. Align each main diesel generator electrical system and perform four hour load test. Immediately upon completion of load test remove load as quickly and safely as possible, shutdown diesel generator and perform hot megger readings. Record all data, as listed, on data sheets provided.

3.7 **Transient Load Test -** Demonstrate proper response of each main diesel generator's governor with respect to momentary speed variations. This will be proven by using a load bank or equivalent. As per manufacturer requirements and classification approval, a maximum of 35% load will be applied at one time. A shipyard provided chart recorder will be used to record line voltage, current and frequency. Record al data, as listed, on data sheet provided.

3.8 **Reverse Power Relays Test -** Prove proper operation of main diesel generator reverse power relays. Demonstrate the ability of each reverse power relay to trip their respective generator breaker utilizing all possible combinations of diesel generators. Record all data, as listed, on data sheet provided.

MAIN DIESEL ENGINE FUEL BOOSTER PUMPS **Hull # ______**

OPERATIONAL TEST					
ITEM NUMBER		**01**	**02**	**03**	**04**
Description	**Design**	**Actual**			
MOTOR		MDG # 1	MDG # 2	MDG # 3	MDG # 4
Volts:	460 V (+ 28, - 46)				
Amps: Phase A	≤ 3.5				
Amps: Phase B	≤ 3.5				
Amps: Phase C	≤ 3.5				
Rotation:	SAT / UNSAT				
RPM:	3585 (± 143)				
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
Bearing Temp:	SAT / UNSAT				
Frame Temp:	SAT / UNSAT				
CONTROLLER					
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
PUMP					
Discharge Pressure (bar)	6.0 (± .2)				
Suction Pressure (bar)	N/A				
Relief Valve setting	N/A				
Bearing Temp:	SAT / UNSAT				
OBSERVATIONS					
Noise:	SAT / UNSAT				
Vibration:	SAT / UNSAT				
Casing Temp:	SAT / UNSAT				
Leakage:	SAT / UNSAT				
Lubrication:	SAT / UNSAT				
WITNESSED BY					
SHIPBUILDER					
CUSTOMER					
DATE					

MAIN DIESEL ENGINE TURNING GEARS Hull # ______

OPERATIONAL TEST					
ITEM NUMBER		**05**	**06**	**07**	**08**
Description	**Design**	**Actual**			
MOTOR		MDG # 1	MDG # 2	MDG # 3	MDG # 4
Volts:	460 V (+ 28, - 46)				
Amps: Phase A	≤ 4.9				
Amps: Phase B	≤ 4.9				
Amps: Phase C	≤ 4.9				
Rotation:	SAT / UNSAT				
RPM:	1780 (±71)				
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
Bearing Temp:	SAT / UNSAT				
Frame Temp:	SAT / UNSAT				
CONTROLLER					
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
OBSERVATIONS					
Noise:	SAT / UNSAT				
Vibration:	SAT / UNSAT				
Casing Temp:	SAT / UNSAT				
Leakage:	SAT / UNSAT				
Lubrication:	SAT / UNSAT				
WITNESSED BY					
SHIPBUILDER					
CUSTOMER					
DATE					

MAIN DIESEL PRE-LUBE OIL PUMPS Hull # ____

OPERATIONAL TEST					
ITEM NUMBER		**09**	**10**	**11**	**12**
Description	**Design**	**Actual**			
MOTOR		MDG # 1	MDG # 2	MDG # 3	MDG # 4
Volts:	460 V (+ 28, - 46)				
Amps: Phase A	≤ 4.9				
Amps: Phase B	≤ 4.9				
Amps: Phase C	≤ 4.9				
Rotation:	SAT / UNSAT				
RPM:	3450				
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
Bearing Temp:	SAT / UNSAT				
Frame Temp:	SAT / UNSAT				
CONTROLLER					
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
PUMP					
Discharge Pressure (bar)	N/A				
Suction Pressure (bar)	N/A				
Relief Valve setting	N/A				
Bearing Temp:	SAT / UNSAT				
OBSERVATIONS					
Noise:	SAT / UNSAT				
Vibration:	SAT / UNSAT				
Casing Temp:	SAT / UNSAT				
Leakage:	SAT / UNSAT				
Lubrication:	SAT / UNSAT				
WITNESSED BY					
SHIPBUILDER					
CUSTOMER					
DATE					

MAIN DIESEL GENERATOR PRE-LUBE OIL PUMPS (DRIVE END) Hull # ____

OPERATIONAL TEST					
ITEM NUMBER		**13**	**14**	**15**	**16**
Description	**Design**	**Actual**			
MOTOR		MDG # 1	MDG # 2	MDG # 3	MDG # 4
Volts:	460 V (+ 28, - 46)				
Amps: Phase A	≤ 4.0				
Amps: Phase B	≤ 4.0				
Amps: Phase C	≤ 4.0				
Rotation:	SAT / UNSAT				
RPM:	3450 (± 138)				
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
Bearing Temp:	SAT / UNSAT				
Frame Temp:	SAT / UNSAT				
CONTROLLER					
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
PUMP					
Discharge Pressure (bar)	N/A				
Suction Pressure (bar)	N/A				
Relief Valve setting	N/A				
Bearing Temp:	SAT / UNSAT				
OBSERVATIONS					
Noise:	SAT / UNSAT				
Vibration:	SAT / UNSAT				
Casing Temp:	SAT / UNSAT				
Leakage:	SAT / UNSAT				
Lubrication:	SAT / UNSAT				
WITNESSED BY					
SHIPBUILDER					
CUSTOMER					
DATE					

MAIN DIESEL GENERATOR PRE-LUBE OIL PUMPS (EXCITER END) Hull # ____

OPERATIONAL TEST					
ITEM NUMBER		**17**	**18**	**19**	**20**
Description	**Design**	**Actual**			
MOTOR		MDG # 1	MDG # 2	MDG # 3	MDG # 4
Volts:	460 V (+ 28, - 46)				
Amps: Phase A	≤ 4.0				
Amps: Phase B	≤ 4.0				
Amps: Phase C	≤ 4.0				
Rotation:	SAT / UNSAT				
RPM:	3450 (± 138)				
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
Bearing Temp:	SAT / UNSAT				
Frame Temp:	SAT / UNSAT				
CONTROLLER					
Cold Insulation Resistance:	≥ 1MΩ				
Hot Insulation Resistance:	≥ 1MΩ				
PUMP					
Discharge Pressure (bar)	N/A				
Suction Pressure (bar)	N/A				
Relief Valve setting	N/A				
Bearing Temp:	SAT / UNSAT				
OBSERVATIONS					
Noise:	SAT / UNSAT				
Vibration:	SAT / UNSAT				
Casing Temp:	SAT / UNSAT				
Leakage:	SAT / UNSAT				
Lubrication:	SAT / UNSAT				
WITNESSED BY					
SHIPBUILDER					
CUSTOMER					
DATE					

MAIN DIESEL GENERATOR # 1

ITEM NUMBER 21	OPERATIONAL TEST		Hull #:______		
Description	**Design**	**Actual**	**Witnessed by**		
SAFETY ALARMS & SHUTDOWNS			**Customer**	**Shipbuilder**	**Date**
MDG Low Pre-lube Pressure (bar)	Alarms @ ⇓ 0.75 (± .1) Trips @ ⇓ 0.5 (± .1)	Alarms @______ Trips @_______			
MDG Low Lube Oil Pressure (bar)	Alarms @ ⇓ 2.5 (± .2) Trips @ ⇓ 2.0 (± .2)	Alarms @______ Trips @_______			
MDG Low Jacket Water Pressure (bar)	Alarms @ ⇓ 2.0 (± .2) Trips @ ⇓ 1.5 (± .2)	Alarms @______ Trips @_______			
MDG High Cooling Water Temperature (°C)	Alarms @ ⇑ 112 (± 3) Trips @ ⇑ 120 (± 3)	Alarms @______ Trips @_______			
MDG High Oil Temperature (°C)	Alarms @ ⇑ 90 (± 3) Trips @ ⇑ 98 (± 3)	Alarms @______ Trips @_______			
MDG Thrust Bearing Temp high (°C)	Trips @ ⇑ 110 (±3)	Trips @_______			
MDG Low Fuel Oil Pressure (bar)	Alarms @ ⇓ 2.0 (± .2)	Alarms @______			
Mechanical Overspeed (RPM)	Trips @ ⇑ 596 (± 10%)	Trips @_______			
Electrical Overspeed (RPM)	Trips @ ⇑ 586 (± 10%)	Trips @_______			
Turbocharger Lube Oil Temperature High (°C)	Alarms @ ⇑ 90 (± 3)	Alarms @______			
Generator Low Pre-lube Pressure (bar)	Trips @ ⇓ 1.0 (± .2)	Trips @_______			
Generator Low Lube Oil Pressure (bar)	Alarms @ ⇓ 2.0 (± .2 Trips @ ⇓ 1.5 (± .2)	Alarms @______ Trips @_______			
MDG Jacking Gear Engaged (Interlock no start)	SAT / UNSAT				
Generator Leakage Detector	SAT / UNSAT				
OPERATIONS					
Manual Controls at Diesel Engine	SAT / UNSAT				
Manual Controls at D.G. Switch Cubicle	SAT / UNSAT				
Manual Controls at H.V. Switchboards	SAT / UNSAT				
Voltage Regulator -- Manual	SAT / UNSAT				
Voltage Regulator -- Automatic	Min. 461 volts Max. 499 volts	Min @ ______ Max @ ______			
Governor Control Range	Min. 58.5 Hz. Max. 61.5 Hz.	Min @ ______ Max @ ______			
Oil Mist Detector	SAT / UNSAT				

ITEM NUMBER 21	OPERATIONAL TEST		Hull #:______		
Description	**Design**	**Actual**	**Witnessed by**		
Generator Heaters	SAT / UNSAT				

MAIN DIESEL GENERATOR # 2

ITEM NUMBER 22	**OPERATIONAL TEST**		Hull #:______		
Description	**Design**	**Actual**	**Witnessed by**		
SAFETY ALARMS & SHUTDOWNS			**Customer**	**Shipbuilder**	**Date**
MDG Low Pre-lube Pressure (bar)	Alarms @ ⇓ 0.75 (± .1) Trips @ ⇓ 0.5 (± .1)	Alarms @______ Trips @_______			
MDG Low Lube Oil Pressure (bar)	Alarms @ ⇓ 2.5 (± .2) Trips @ ⇓ 2.0 (± .2)	Alarms @______ Trips @_______			
MDG Low Jacket Water Pressure (bar)	Alarms @ ⇓ 2.0 (± .2) Trips @ ⇓ 1.5 (± .2)	Alarms @______ Trips @_______			
MDG High Cooling Water Temperature (°C)	Alarms @ ⇑ 112 (± 3) Trips @ ⇑ 120 (± 3)	Alarms @______ Trips @_______			
MDG High Oil Temperature (°C)	Alarms @ ⇑ 90 (± 3) Trips @ ⇑ 98 (± 3)	Alarms @______ Trips @_______			
MDG Thrust Bearing Temp high (°C)	Trips @ ⇑ 110 (±3)	Trips @_______			
MDG Low Fuel Oil Pressure (bar)	Alarms @ ⇓ 2.0 (± .2)	Alarms @______			
Mechanical Overspeed (RPM)	Trips @ ⇑ 596 (± 10%)	Trips @_______			
Electrical Overspeed (RPM)	Trips @ ⇑ 586 (± 10%)	Trips @_______			
Turbocharger Lube Oil Temperature High (°C)	Alarms @ ⇑ 90 (± 3)	Alarms @______			
Generator Low Pre-lube Pressure (bar)	Trips @ ⇓ 1.0 (± .2)	Trips @_______			
Generator Low Lube Oil Pressure (bar)	Alarms @ ⇓ 2.0 (± .2 Trips @ ⇓ 1.5 (± .2)	Alarms @______ Trips @_______			
MDG Jacking Gear Engaged (Interlock no start)	SAT / UNSAT				
Generator Leakage Detector	SAT / UNSAT				
OPERATIONS					
Manual Controls at Diesel Engine	SAT / UNSAT				
Manual Controls at D.G. Switch Cubicle	SAT / UNSAT				
Manual Controls at H.V. Switchboards	SAT / UNSAT				
Voltage Regulator -- Manual	SAT / UNSAT				
Voltage Regulator -- Automatic	Min. 461 volts Max. 499 volts	Min @ ______ Max @ ______			
Governor Control Range	Min. 58.5 Hz. Max. 61.5 Hz.	Min @ ______ Max @ ______			
Oil Mist Detector	SAT / UNSAT				

ITEM NUMBER 22		OPERATIONAL TEST	Hull #:______		
Description	**Design**	**Actual**	**Witnessed by**		
Generator Heaters	SAT / UNSAT				

MAIN DIESEL GENERATOR # 3

ITEM NUMBER 23	**OPERATIONAL TEST**		**Hull #:______**		
Description	**Design**	**Actual**	**Witnessed by**		
SAFETY ALARMS & SHUTDOWNS			**Customer**	**Shipbuilder**	**Date**
MDG Low Pre-lube Pressure (bar)	Alarms @ ⇓ 0.75 (± .1) Trips @ ⇓ 0.5 (± .1)	Alarms @______ Trips @_______			
MDG Low Lube Oil Pressure (bar)	Alarms @ ⇓ 2.5 (± .2) Trips @ ⇓ 2.0 (± .2)	Alarms @______ Trips @_______			
MDG Low Jacket Water Pressure (bar)	Alarms @ ⇓ 2.0 (± .2) Trips @ ⇓ 1.5 (± .2)	Alarms @______ Trips @_______			
MDG High Cooling Water Temperature (°C)	Alarms @ ⇑ 112 (± 3) Trips @ ⇑ 120 (± 3)	Alarms @______ Trips @_______			
MDG High Oil Temperature (°C)	Alarms @ ⇑ 90 (± 3) Trips @ ⇑ 98 (± 3)	Alarms @______ Trips @_______			
MDG Thrust Bearing Temp high (°C)	Trips @ ⇑ 110 (±3)	Trips @_______			
MDG Low Fuel Oil Pressure (bar)	Alarms @ ⇓ 2.0 (± .2)	Alarms @______			
Mechanical Overspeed (RPM)	Trips @ ⇑ 596 (± 10%)	Trips @_______			
Electrical Overspeed (RPM)	Trips @ ⇑ 586 (± 10%)	Trips @_______			
Turbocharger Lube Oil Temperature High (°C)	Alarms @ ⇑ 90 (± 3)	Alarms @______			
Generator Low Pre-lube Pressure (bar)	Trips @ ⇓ 1.0 (± .2)	Trips @_______			
Generator Low Lube Oil Pressure (bar)	Alarms @ ⇓ 2.0 (± .2 Trips @ ⇓ 1.5 (± .2)	Alarms @______ Trips @_______			
MDG Jacking Gear Engaged (Interlock no start)	SAT / UNSAT				
Generator Leakage Detector	SAT / UNSAT				
OPERATIONS					
Manual Controls at Diesel Engine	SAT / UNSAT				
Manual Controls at D.G. Switch Cubicle	SAT / UNSAT				
Manual Controls at H.V. Switchboards	SAT / UNSAT				
Voltage Regulator -- Manual	SAT / UNSAT				
Voltage Regulator -- Automatic	Min. 461 volts Max. 499 volts	Min @ ______ Max @ ______			
Governor Control Range	Min. 58.5 Hz. Max. 61.5 Hz.	Min @ ______ Max @ ______			
Oil Mist Detector	SAT / UNSAT				

<table>
<tr><th colspan="2">ITEM NUMBER 23</th><th colspan="2">OPERATIONAL TEST</th><th colspan="3">Hull #:______</th></tr>
<tr><th>Description</th><th colspan="2">Design</th><th>Actual</th><th colspan="3">Witnessed by</th></tr>
<tr><td>Generator Heaters</td><td colspan="2">SAT / UNSAT</td><td></td><td></td><td></td><td></td></tr>
</table>

MAIN DIESEL GENERATOR # 4

ITEM NUMBER 24	**OPERATIONAL TEST**		Hull #:______		
Description	**Design**	**Actual**	**Witnessed by**		
SAFETY ALARMS & SHUTDOWNS			**Customer**	**Shipbuilder**	**Date**
MDG Low Pre-lube Pressure (bar)	Alarms @ ⇓ 0.75 (± .1) Trips @ ⇓ 0.5 (± .1)	Alarms @______ Trips @_______			
MDG Low Lube Oil Pressure (bar)	Alarms @ ⇓ 2.5 (± .2) Trips @ ⇓ 2.0 (± .2)	Alarms @______ Trips @_______			
MDG Low Jacket Water Pressure (bar)	Alarms @ ⇓ 2.0 (± .2) Trips @ ⇓ 1.5 (± .2)	Alarms @______ Trips @_______			
MDG High Cooling Water Temperature (°C)	Alarms @ ⇑ 112 (± 3) Trips @ ⇑ 120 (± 3)	Alarms @______ Trips @_______			
MDG High Oil Temperature (°C)	Alarms @ ⇑ 90 (± 3) Trips @ ⇑ 98 (± 3)	Alarms @______ Trips @_______			
MDG Thrust Bearing Temp high (°C)	Trips @ ⇑ 110 (±3)	Trips @_______			
MDG Low Fuel Oil Pressure (bar)	Alarms @ ⇓ 2.0 (± .2)	Alarms @______			
Mechanical Overspeed (RPM)	Trips @ ⇑ 596 (± 10%)	Trips @_______			
Electrical Overspeed (RPM)	Trips @ ⇑ 586 (± 10%)	Trips @_______			
Turbocharger Lube Oil Temperature High (°C)	Alarms @ ⇑ 90 (± 3)	Alarms @______			
Generator Low Pre-lube Pressure (bar)	Trips @ ⇓ 1.0 (± .2)	Trips @_______			
Generator Low Lube Oil Pressure (bar)	Alarms @ ⇓ 2.0 (± .2 Trips @ ⇓ 1.5 (± .2)	Alarms @______ Trips @_______			
MDG Jacking Gear Engaged (Interlock no start)	SAT / UNSAT				
Generator Leakage Detector	SAT / UNSAT				
OPERATIONS					
Manual Controls at Diesel Engine	SAT / UNSAT				
Manual Controls at D.G. Switch Cubicle	SAT / UNSAT				
Manual Controls at H.V. Switchboards	SAT / UNSAT				
Voltage Regulator -- Manual	SAT / UNSAT				
Voltage Regulator -- Automatic	Min. 461 volts Max. 499 volts	Min @ ______ Max @ ______			
Governor Control Range	Min. 58.5 Hz. Max. 61.5 Hz.	Min @ ______ Max @ ______			
Oil Mist Detector	SAT / UNSAT				

ITEM NUMBER 24	OPERATIONAL TEST		Hull #:______		
Description	**Design**	**Actual**	**Witnessed by**		
Generator Heaters	SAT / UNSAT				

MAIN DIESEL GENERATOR # 1

ITEM NUMBER 25		**LOAD TEST**		Hull Number_______		
READING (@ 100 % Load)	**Design**	**Start**	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Power (kw)	6300 (± 63)					
Voltage Phase A – B (ac)	6.6k (± 264)					
Voltage Phase A – C (ac)	6.6k (± 264)					
Voltage Phase B – C (ac)	6.6k (± 264)					
Current Phase A (amps)	660 to 675					
Current Phase B (amps)	660 to 675					
Current Phase C (amps)	660 to 675					
Frequency (hz)	60 (± 3)					
Ambient temperature (°C)	< 50					
Stator Temperature (°C) (Highest)	< 155					
Generator Cooling Air Temperature Inlet (°C)	< 155					
Generator Cooling Air Temperature Outlet (°C)	< 155					
Generator Bearing Temperature (°C) Exciter end	< 82					
Generator Oil Temperature (°C) Exciter end	< 82					
Generator Oil Temperature (°C) Drive end	< 82					
Generator Bearing Temperature (°C) Drive end	< 82					
Diesel Lube Oil Inlet Pressure (bar)	> 2.5					
Diesel Lube Oil Inlet Temperature (°C)	< 90					
Diesel Lube Oil Differential Pressure (bar)	< 0.75					
Diesel Fuel Oil Pressure	> 3.0					
Diesel Fuel Oil Differential Pressure (bar)	< 0.5					
Diesel Fuel Oil Inlet Temperature (°C)	< 80					
HT Cooling Water Inlet Temperature (°C)	< 112					
HT Cooling Water Outlet Temperature (°C)	< 112					

MAIN DIESEL GENERATOR # 1

Con't		**LOAD TEST**		Hull Number_______		
READING (@ 100 % Load)	**Design**	**Start**	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Exhaust Temperature Cyl # 1 (°C)	< 650					
Exhaust Temperature Cyl # 2 (°C)	< 650					
Exhaust Temperature Cyl # 3 (°C)	< 650					
Exhaust Temperature Cyl # 4 (°C)	< 650					
Exhaust Temperature Cyl # 5 (°C)	< 650					
Exhaust Temperature Cyl # 6 (°C)	< 650					
Exhaust Temperature Cyl # 7 (°C)	< 650					
Exhaust Temperature Cyl # 8 (°C)	< 650					
Turbocharger Outlet Temperature (°C)	< 650					

WITNESSED BY	**DATE**
SHIPBUILDER:	
CUSTOMER:	

MAIN DIESEL GENERATOR # 2

ITEM NUMBER __26		**LOAD TEST**			Hull Number_______	
READING (@ 100 % Load)	**Design**	**Start**	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Power (kw)	6300 (± 63)					
Voltage Phase A – B (ac)	6.6k (± 264)					
Voltage Phase A – C (ac)	6.6k (± 264)					
Voltage Phase B – C (ac)	6.6k (± 264)					
Current Phase A (amps)	660 to 675					
Current Phase B (amps)	660 to 675					
Current Phase C (amps)	660 to 675					
Frequency (hz)	60 (± 3)					
Ambient temperature (°C)	< 50					
Stator Temperature (°C) (Highest)	< 155					
Generator Cooling Air Temperature Inlet (°C)	< 155					
Generator Cooling Air Temperature Outlet (°C)	< 155					
Generator Bearing Temperature (°C) Exciter end	< 82					
Generator Oil Temperature (°C) Exciter end	< 82					
Generator Oil Temperature (°C) Drive end	< 82					
Generator Bearing Temperature (°C) Drive end	< 82					
Diesel Lube Oil Inlet Pressure (bar)	> 2.5					
Diesel Lube Oil Inlet Temperature (°C)	< 90					
Diesel Lube Oil Differential Pressure (bar)	< 0.75					
Diesel Fuel Oil Pressure	> 3.0					
Diesel Fuel Oil Differential Pressure (bar)	< 0.5					
Diesel Fuel Oil Inlet Temperature (°C)	< 80					
HT Cooling Water Inlet Temperature (°C)	< 112					
HT Cooling Water Outlet Temperature (°C)	< 112					

MAIN DIESEL GENERATOR # 2

Con't			**LOAD TEST**		Hull Number_______	
READING (@ 100 % Load)	**Design**	**Start**	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Exhaust Temperature Cyl # 1 (°C)	< 650					
Exhaust Temperature Cyl # 2 (°C)	< 650					
Exhaust Temperature Cyl # 3 (°C)	< 650					
Exhaust Temperature Cyl # 4 (°C)	< 650					
Exhaust Temperature Cyl # 5 (°C)	< 650					
Exhaust Temperature Cyl # 6 (°C)	< 650					
Exhaust Temperature Cyl # 7 (°C)	< 650					
Exhaust Temperature Cyl # 8 (°C)	< 650					
Turbocharger Outlet Temperature (°C)	< 650					

WITNESSED BY	**DATE**
SHIPBUILDER:	
CUSTOMER:	

MAIN DIESEL GENERATOR # 3

ITEM NUMBER 27		**LOAD TEST**		Hull # ________		
READING (@ 100 % Load)	**Design**	**Start**	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Power (kw)	6300 (± 63)					
Voltage Phase A – B (ac)	6.6k (± 264)					
Voltage Phase A – C (ac)	6.6k (± 264)					
Voltage Phase B – C (ac)	6.6k (± 264)					
Current Phase A (amps)	660 to 675					
Current Phase B (amps)	660 to 675					
Current Phase C (amps)	660 to 675					
Frequency (hz)	60 (± 3)					
Ambient temperature (°C)	< 50					
Stator Temperature (°C) (Highest)	< 155					
Generator Cooling Air Temperature Inlet (°C)	< 155					
Generator Cooling Air Temperature Outlet (°C)	< 155					
Generator Bearing Temperature (°C) Exciter end	< 82					
Generator Oil Temperature (°C) Exciter end	< 82					
Generator Oil Temperature (°C) Drive end	< 82					
Generator Bearing Temperature (°C) Drive end	< 82					
Diesel Lube Oil Inlet Pressure (bar)	> 2.5					
Diesel Lube Oil Inlet Temperature (°C)	< 90					
Diesel Lube Oil Differential Pressure (bar)	< 0.75					
Diesel Fuel Oil Pressure	> 3.0					
Diesel Fuel Oil Differential Pressure (bar)	< 0.5					
Diesel Fuel Oil Inlet Temperature (°C)	< 80					
HT Cooling Water Inlet Temperature (°C)	< 112					
HT Cooling Water Outlet Temperature (°C)	< 112					

MAIN DIESEL GENERATOR # 3

Con’t	**LOAD TEST**	Hull Number_______				
READING (@ 100 % Load)	**Design**	**Start**	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Exhaust Temperature Cyl # 1 (°C)	< 650					
Exhaust Temperature Cyl # 2 (°C)	< 650					
Exhaust Temperature Cyl # 3 (°C)	< 650					
Exhaust Temperature Cyl # 4 (°C)	< 650					
Exhaust Temperature Cyl # 5 (°C)	< 650					
Exhaust Temperature Cyl # 6 (°C)	< 650					
Exhaust Temperature Cyl # 7 (°C)	< 650					
Exhaust Temperature Cyl # 8 (°C)	< 650					
Turbocharger Outlet Temperature (°C)	< 650					

WITNESSED BY	**DATE**
SHIPBUILDER:	
CUSTOMER:	

MAIN DIESEL GENERATOR # 4

ITEM NUMBER 28		**LOAD TEST**			Hull Number_______	
READING (@ 100 % Load)	**Design**	**Start**	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Power (kw)	6300 (± 63)					
Voltage Phase A – B (ac)	6.6k (± 264)					
Voltage Phase A – C (ac)	6.6k (± 264)					
Voltage Phase B – C (ac)	6.6k (± 264)					
Current Phase A (amps)	660 to 675					
Current Phase B (amps)	660 to 675					
Current Phase C (amps)	660 to 675					
Frequency (hz)	60 (± 3)					
Ambient temperature (°C)	< 50					
Stator Temperature (°C) (Highest)	< 155					
Generator Cooling Air Temperature Inlet (°C)	< 155					
Generator Cooling Air Temperature Outlet (°C)	< 155					
Generator Bearing Temperature (°C) Exciter end	< 82					
Generator Oil Temperature (°C) Exciter end	< 82					
Generator Oil Temperature (°C) Drive end	< 82					
Generator Bearing Temperature (°C) Drive end	< 82					
Diesel Lube Oil Inlet Pressure (bar)	> 2.5					
Diesel Lube Oil Inlet Temperature (°C)	< 90					
Diesel Lube Oil Differential Pressure (bar)	< 0.75					
Diesel Fuel Oil Pressure	> 3.0					
Diesel Fuel Oil Differential Pressure (bar)	< 0.5					
Diesel Fuel Oil Inlet Temperature (°C)	< 80					
HT Cooling Water Inlet Temperature (°C)	< 112					
HT Cooling Water Outlet Temperature (°C)	< 112					

MAIN DIESEL GENERATOR # 4

Con't	**LOAD TEST**	Hull Number_______				
READING (@ 100 % Load)	**Design**	**Start**	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Exhaust Temperature Cyl # 1 (°C)	< 650					
Exhaust Temperature Cyl # 2 (°C)	< 650					
Exhaust Temperature Cyl # 3 (°C)	< 650					
Exhaust Temperature Cyl # 4 (°C)	< 650					
Exhaust Temperature Cyl # 5 (°C)	< 650					
Exhaust Temperature Cyl # 6 (°C)	< 650					
Exhaust Temperature Cyl # 7 (°C)	< 650					
Exhaust Temperature Cyl # 8 (°C)	< 650					
Turbocharger Outlet Temperature (°C)	< 650					

WITNESSED BY	**DATE**
SHIPBUILDER:	
CUSTOMER:	

MAIN DIESEL GENERATORS

OPERATIONAL TESTS #:______						Hull
ITEM #	**Description**	**Design**	**Actual**	**Witnessed by**		
				Customer	**Shipbuilder**	**Date**
29	MDG # 1 Transient Load					
	0 % -- 35 %	≤ 51.4 rpm	Max Δ Rpm _____			
	36 % -- 70 %	≤ 51.4 rpm	Max Δ Rpm _____			
	71 % -- 100 %	≤ 51.4 rpm	Max Δ Rpm _____			
	100 % -- 0 %	≤ 51.4 rpm	Max Δ Rpm _____			
30	MDG # 2 Transient Load					
	0 % -- 35 %	≤ 51.4 rpm	Max Δ Rpm _____			
	36 % -- 70 %	≤ 51.4 rpm	Max Δ Rpm _____			
	71 % -- 100 %	≤ 51.4 rpm	Max Δ Rpm _____			
	100 % -- 0 %	≤ 51.4 rpm	Max Δ Rpm _____			
31	MDG # 3 Transient Load					
	0 % -- 35 %	≤ 51.4 rpm	Max Δ Rpm _____			
	36 % -- 70 %	≤ 51.4 rpm	Max Δ Rpm _____			
	71 % -- 100 %	≤ 51.4 rpm	Max Δ Rpm _____			
	100 % -- 0 %	≤ 51.4 rpm	Max Δ Rpm _____			
32	MDG # 4 Transient Load					
	0 % -- 35 %	≤ 51.4 rpm	Max Δ Rpm _____			
	36 % -- 70 %	≤ 51.4 rpm	Max Δ Rpm _____			
	71 % -- 100 %	≤ 51.4 rpm	Max Δ Rpm _____			
	100 % -- 0 %	≤ 51.4 rpm	Max Δ Rpm _____			
33	MDG # 1 Reverse Power Relay Trips ≤ 8 secs	SAT / UNSAT				
34	MDG # 2 Reverse Power Relay Trips ≤ 8 secs	SAT / UNSAT				
35	MDG # 3 Reverse Power Relay Trips ≤ 8 secs	SAT / UNSAT				
36	MDG # 4 Reverse Power Relay Trips ≤ 8 secs	SAT / UNSAT				

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE EMERGENCY DIESEL GENERATOR		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8605		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 6

NSRP
Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the Emergency Diesel Generator. The operational test of the system will prove proper operation of the following equipment:

1.1 One (1) 600Kw Emergency Diesel Generator set and associated systems

1.2 One (1) Electric driven Jacketwater Pump (EDG)

1.3 One (1) Emergency Switchboard

1.4 One (1) Emergency Diesel Generator Marine Gas Oil Day Tnak

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, Section E-3.0

2.2 Supplemental Test and Inspection Requirements, NSRP-0217

2.3 46 Code of Federal Regulations, Sections 111.12-5 to 12.7, 112.25 & 112.50.

2.4 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Sections 4/5.21.1, 4/5A3.17 & 4/5C2.3

2.5 IEEE Recommended Practice for Electric Installations on Shipboard, Std 45-15, 46.2.2

2.6 Japanese Industrial Standard 8072-86

2.7 International Electro-technical Commission, Part 92-401/11/60

2.8 Lloyd's Register, Classification of Ships, Part 6/2/20.2.4

2.9 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E200 to 202

2.10 Tech Manual - Emergency Diesel Generator

2.11 Tech Manual - Emergency Switchboard

2.12 SOLAS Regulations II 1/43

3 TEST INSTRUCTION

3.1 Align the emergency diesel generator electrical power plant as necessary to perform the following test requirements. It should be noted that the system, which includes the emergency diesel generator, local control panel and emergency switchboard may not be in a normal operating condition during these tests.

3.2 Demonstrate proper operation of jacketwater pre-heater system. During operation of the system record all pump/motor operating data, as listed, on data sheet provided. Design data not shown on the data sheet shall be obtained from subject equipment nameplate data, and entered on the data sheet.

3.3 Prove proper operation of the emergency generator's safety and alarm systems IAW reference 2.10. Demonstrate satisfactory operation of each alarm and safety device listed on the data sheet. Record all data, as listed, on data sheet provided.

3.4 Demonstrate proper operation of all manual and local controls associated with the emergency diesel generator IAW reference 2.10. Record all data, as listed, on data sheet provided.

3.5 Demonstrate proper operation of generator heaters and ventilation dampers. Record all data, as listed, on data sheet provided.

3.6 Perform cold megger readings before start-up of diesel. Align the emergency diesel generator electrical system and perform four hour load test. A stable load will be required to perform this test. A load bank or equivalent should be used to maintain a stable load during this testing period. Immediately upon completion of load test remove load as quickly and safely as possible, shutdown diesel and perform hot megger readings. Record all data, as listed, on data sheet provided.

3.7 Demonstrate the performance of the starting air system. The diesel generator shall not have been run prior to this demonstration. The starting air system should be fully charged. Demonstrate the ability of the starting system to consecutively start the EDG a minimum of six times. Record all data, as listed, on data sheet provided.

3.8 Realign, if required, the emergency diesel generator electrical power plant to original power plant configuration. Demonstrate proper operation of all remote operations. This includes the automatic/feedback system. Use references 2.10 & 2.11 for guidance. Record all data, as listed, on data sheet provided.

Item # ____ **EMERGENCY DIESEL JACKETWATER PUMP** Hull Number:______

OPERATIONAL TEST		
Description	**Design**	**Actual**
MOTOR		
Volts:	480 VAC (+29 -48)	
Amps: Phase A	≤ 3.2 AMPS	
Amps: Phase B	≤ 3.2 AMPS	
Amps: Phase C	≤ 3.2 AMPS	
Rotation:	SAT / UNSAT	
RPM:	1780 RPM (71)	
Cold Insulation Resistance:	>1MΩ	
Hot Insulation Resistance:	>1MΩ	
Bearing Temperature:	SAT / UNSAT	
Frame Temperature:	SAT / UNSAT	
CONTROLLER		
Cold Insulation Resistance:	>1MΩ	
Hot Insulation Resistance:	>1MΩ	
PUMP		
System Discharge Pressure:	1.5 BAR (±.2)	
System Suction Pressure:	N/A	
Relief Valve setting	1.7 BAR (±.2)	
Bearing Temperature:	SAT / UNSAT	
OBSERVATIONS		
Noise:	SAT / UNSAT	
Vibration:	SAT / UNSAT	
Casing Temperature:	SAT / UNSAT	
Leakage:	SAT / UNSAT	
Lubrication:	SAT / UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

EMERGENCY DIESEL SAFETIES & OPERATIONAL TEST				Hull Number:______		
Item #	**Description**	**Design**	**Actual**	**Witnessed by**		
				Customer	**Shipbuilder**	**Date**
1	**SAFETY ALARMS & SHUTDOWNS**					
	Low Lube Oil Pressure	⇓ .7 bar (±.2)				
	High Cooling Water Temperature	⇑ 96 °C (± 3°)				
	High Oil Temperature	⇑ 115 °C (± 3°)				
	Overcrank Alarm, Cut-out	⇑ 13 sec (±1)				
	Electrical Overspeed	⇑ 1980 rpm (±50)				
2	**LOCAL OPERATIONS**					
	Manual / Local Controls	SAT / UNSAT				
	Jacketwater Pre-heater	SAT / UNSAT				
	Ventilation Dampers Open/Close	SAT / UNSAT				
	Generator Heater(s)	SAT / UNSAT				
	Voltage Regulator Auto Range	Min = 445 volts Max = 505 volts	Min = ________ Max = ________			
	Voltage Regulator Manual Range	Variable	Min =.________ Max = ________			
	Governor Range (no load)	Min = 57 hz Max = 63 hz	Min = ________ Max = ________			
4	**INSULATION RESISTANCE**					
	Stator Cold reading	> 2 MΩ				
	Stator Hot reading	> 2 MΩ				
	Exciter Cold reading	> 2 MΩ				
	Exciter Hot reading	> 2 MΩ				
5	**NUMBER OF STARTS**	≥ 6 starts				
6	**REMOTE OPERATIONS**					
	Auto Position / Cold Start Dead Bus start	Diesel Gen. starts and assumes Emerg. Swbd load ≤ 45 sec.				
	Test Position	Diesel Gen. Starts, opens Mn Swbd Breaker and assumes Emerg. Swbd load				

EMERGENCY DIESEL SAFETIES & OPERATIONAL TEST				Hull Number:______		
Item #	**Description**	**Design**	**Actual**	**Witnessed by**		
	Feedback Position	SAT/UNSAT				

ITEM#___	**EMERGENCY DIESEL FULL LOAD TEST**					Hull Number______
READING (@ 100 % Load)	**Expected Results**	**Start** (Full load)	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 4**
Diesel Lube Oil Pressure (bar)	>0.7					
Diesel Lube Oil Temperature (°C)	<115°					
Cooling Water Temperature (°C)	<96°					
Exhaust Temperature (°C)	<471°					
Compartment Ambient (°C)	N/A					
Speed (RPM)	1800 (± 72)					
Load (KW)	600 (± 9)					
Volts (Volts)	480 (± 12)					
Amps	Approx. 730 amps (1.0 pf)					
Frequency (Hz)	60 ± (1.2)					
Stator Temperature (°C)---(Highest)	<120°					

WITNESSED BY	DATE
SHIPBUILDER	
CUSTOMER	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE BATTERIES AND CHARGERS		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8607		DRAFT
DATE			
	SCALE: NONE	SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the batteries, chargers, and Uninterrupted Power Supply (UPS) systems on the ship. The operational tests will prove proper operation of the following equipment:

1.1 One (1) 24VDC Battery Charger – General Distribution

1.2 One (1) Model 525 UPS

1.3 Two (2) 12.5 KVA UPS

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, Section E-11.0

2.2 American Bureau of Shipping, Rules Part 4/5.21.1

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E/401

2.4 Japanese Industrial Standard 8072-86

2.5 Lloyd’s Register, Classification of Ships, 6/2/20.2.4

2.6 Tech Manual – Battery Charger

2.7 Tech Manual – 525 UPS

2.8 Tech Manual – 12.5KVA UPS

3 TEST INSTRUCTION

3.1 Verify the ventilation interlock of the battery charger by demonstrating that the battery charger shuts off when exhaust ventilation to the space is secured. Record data, as appropriate, on data sheet provided.

3.2 Use reference 2.6 through 2.8 as guides to perform the following steps.

3.3 Demonstrate satisfactory operation of the 24VDC-battery charger using both manual and automatic controls. Verify alarm-monitoring system is activated when charger is secured. Record data, as appropriate, on data sheet provided.

3.4 Demonstrate 24VDC-battery bank is able to maintain ship’s load for thirty (30) minutes. Record data, as appropriate, on data sheet provided.

3.5 Verify battery charger will charge battery bank after load test. Record data, as appropriate, on data sheet provided.

3.6 Demonstrate satisfactory operation of the model 525 UPS system using both manual and automatic controls. Verify alarm-monitoring system is activated when UPS is secured. Record data, as appropriate, on data sheet provided.

3.7 Demonstrate the capability of the model 525 UPS to supply its load with battery power for fifteen (15) minutes with the external power source secured. Ensure that power is transferred with no service interruption. Record data, as appropriate, on data sheet provided.

3.8 Verify the UPS will charge battery bank after the load test. Record data, as appropriate, on data sheet provided.

3.9 Demonstrate satisfactory operation of each 12.5 KVA UPS systems using both manual and automatic controls. Verify alarm-monitoring system is activated when UPS is secured. Record data, as appropriate, on data sheet provided.

3.10 Demonstrate the capability of the 12.5 KVA UPS to supply its load with battery power for thirty (30) minutes with the external power source secured. Ensure that power is transferred with no service interruption. Record data, as appropriate, on data sheet provided.

3.11 Verify the UPS will charge battery bank after the load test. Record data, as appropriate, on data sheet provided.

BATTERIES AND CHARGERS

		OPERATIONAL TEST		Hull Number_______		
Item #	**Description**	**Operation**		**WITNESSED BY**		
		Design	Actual	Customer	Shipbuilder	Date
1	**24 VDC Battery Charger**					
	Ventilation Interlock Battery Charger turns off	SAT / UNSAT				
	Manual Controls	SAT / UNSAT				
	Automatic Controls	SAT / UNSAT				
	Remote Alarm to MCCS	SAT / UNSAT				
2	**Load Test of 24VDC System** (Ship's Load)	≥ 22 VDC ≥ 30 minutes	Volts ______ Time ______			
3	**Charge Battery Bank**	≥ 24 VDC ≤ 8 hours	Volts ______ Time ______			
4	**525 UPS**					
	Manual Controls	SAT / UNSAT				
	Automatic Controls	SAT / UNSAT				
	Remote Alarm to MCCS	SAT / UNSAT				
5	**Load Test of 525 UPS system** (Ship's Load)	≥ 115 VAC ≥ 15 minutes	Volts ______ Time ______			
6	**Charge Battery Bank**	≥ 120 VAC ≤ 4 hours	Volts ______ Time ______			
7	**12.5 KVA UPS #1**					
	Manual Controls	SAT / UNSAT				
	Automatic Controls	SAT / UNSAT				
	Remote Alarm to MCCS	SAT / UNSAT				
8	**Load Test of 12.5 KVA UPS System** (Ship's Load)	≥ 115 VAC ≥ 30 minutes	Volts ______ Time ______			
9	**Charge Battery Bank**	≥ 120 VAC ≤ 8 hours	Volts ______ Time ______			
10	**12.5 KVA UPS #2**					
	Manual Controls	SAT / UNSAT				
	Automatic Controls	SAT / UNSAT				
	Remote Alarm to MCCS	SAT / UNSAT				
11	**Load Test of 12.5 KVA UPS System** (Ship's Load)	≥ 115 VAC ≥ 30 minutes	Volts ______ Time ______			
12	**Charge Battery Bank**	≥ 120 VAC ≤ 8 hours	Volts ______ Time ______			

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE LIGHTING SYSTEM OPERATION		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8613		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the normal and emergency lighting systems. Installation crews have performed the insulation resistance readings. Operational tests will prove proper operation of the following equipment:

1.1 One (1) Normal Lighting System of the Ship

1.2 One (1) Emergency Lighting System of the Ship

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, Section E-9.0

2.2 46 CFR 112.15

2.3 American Bureau of Shipping, Rules Part 4/5.21.1

2.4 IEEE 45-46.2.5

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E100

2.4 Japanese Industrial Standard 8072-86

2.5 Lloyd's Register, Classification of Ships, 6/2/20.2.6

2.6 Normal Lighting system drawing

2.7 Emergency lighting system drawing

3 TEST INSTRUCTION

3.1 Verify satisfactory operation of general lighting system. Operate on/off switches and verify that all lights are operational. For demonstration purposes, the ship has been divided into fourteen zones as indicated on the data sheets. Record data, as appropriate, on data sheet provided.

3.2 Secure all general lighting and demonstrate to the satisfaction of surveyor that the emergency lighting is adequate for operation of essential equipment and closed spaces to open decks. Verify that all emergency lights have been properly identified. For demonstration purposes, ship has been divided into fourteen zones as indicated on the data sheets. Record data, as appropriate, on data sheet provided.

GENERAL LIGHTING TEST

		OPERATIONAL TEST		Hull Number_______		
Item #	**Description**	**Operation**		**WITNESSED BY**		
		Design	Actual	Customer	Shipbuilder	Date
1	Weather Deck (Fwd of House)	SAT /UNSAT				
2	Weather Deck (Aft of House)	SAT /UNSAT				
3	Forecastle Area	SAT /UNSAT				
4	House “A” Deck	SAT /UNSAT				
5	House “B” Deck	SAT /UNSAT				
6	House “C” Deck	SAT /UNSAT				
7	House “D” Deck	SAT /UNSAT				
8	Navigational Bridge Deck	SAT /UNSAT				
9	Machinery Room #1	SAT /UNSAT				
10	Machinery Room #2	SAT /UNSAT				
11	Machinery Casing Areas	SAT /UNSAT				
12	Steering Gear Room #1	SAT /UNSAT				
13	Steering Gear Room #2	SAT /UNSAT				
14	Storage Compartments - Aft	SAT /UNSAT				

EMERGENCY LIGHTING TEST

		OPERATIONAL TEST			Hull Number_______	
Item #	**Description**	**Operation**		**WITNESSED BY**		
		Design	Actual	Customer	Shipbuilder	Date
1	Weather Deck (Fwd of House)	SAT /UNSAT				
2	Weather Deck (Aft of House)	SAT /UNSAT				
3	Forecastle Area	SAT /UNSAT				
4	House “A” Deck	SAT /UNSAT				
5	House “B” Deck	SAT /UNSAT				
6	House “C” Deck	SAT /UNSAT				
7	House “D” Deck	SAT /UNSAT				
8	Navigational Bridge Deck	SAT /UNSAT				
9	Machinery Room #1	SAT /UNSAT				
10	Machinery Room #2	SAT /UNSAT				
11	Machinery Casing Areas	SAT /UNSAT				
12	Steering Gear Room #1	SAT /UNSAT				
13	Steering Gear Room #2	SAT /UNSAT				
14	Storage Compartments - Aft	SAT /UNSAT				

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE NAVIGATION AND SIGNAL LIGHTS		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8655		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 5

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the navigation and signal lights. The operational tests will prove proper operation of the following equipment:

1.1 One (1) Masthead light, foremast

1.2 One (1) Mast head light, radar mast

1.3 One (1) Stern light

1.4 One (1) Port side light

1.5 One (1) Starboard side light

1.6 One (1) Anchor light

1.7 One (1) Not under-command light

1.8 One (1) Morse/maneuvering light

1.9 One (1) Steering light

1.10 One (1) Searchlight

1.11 One (1) Suez canal light system

1.12 One (1) Dangerous cargo light

1.13 One (1) Huge vessel light

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section N-6.0

2.2 46 Code of Federal Regulations, Section 111.75-17

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/8/3/A500

2.4 Japanese Industrial Standard 8069-86, 8072-86

2.5 Lloyd's Register, Classification of Ships, Part 6/2/14.5, 6/2/20.2

2.6 American Bureau of Shipping, Rules Part 4/5/21.1

2.7 International Convention for the Prevention of Collison at Sea, 1972

2.8 Rules of Navigation of the Suez Canal Authority, 1992

2.9 Navigation and Signal Lights Location, Block Wiring Diagram, and Elementary Wiring Diagram, Dwg. No. 7250-346-0109 Rev. -

2.10 Tech Manual - Navigation Panel

3 TEST INSTRUCTION

3.1 Demonstrate satisfactory operation of each light listed on the data sheet. Record all data, as listed, on data sheets provided.

3.2 Verify correct location of all lights listed on data sheet. Record data, as appropriate, on data sheets provided.

3.3 Verify correct color of lights listed on data sheet. Record data, as appropriate, on data sheets provided.

3.4 Demonstrate proper operation of mimic panel. Record data, as appropriate, on data sheets provided.

NAVIGATION AND SIGNAL LIGHTS LOCATION AND OPERATIONAL TEST									Hull Number:______
Item #	**QTY**	**Description**	**Operation**	**Location**	**Color**		**Witnessed by**		
			(SAT/UNSAT)	ACTUAL	EXPECTED	ACTUAL	Customer	Shipbuilder	Date
01	1	Masthead light, foremast			White/White				
02	1	Mast head light, radar mast			White/White				
03	1	Stern light			White/White				
04	1	Port side light			Red/Red				
05	1	Starboard side light			Green/Green				
06	2	Anchor light			White				
07	2	Not under-command light			Red				
08	1	Morse/maneuvering light			White				
09	N/A	Wheelhouse key							
10	1	Stbd bridge wing key							
11	1	Port bridge wing key							
12	1	Steering light			Blue				
13	1	Searchlight (starboard)			Clear				
14	1	Searchlight (port)			Clear				
		Suez canal light system							
15	1	Stern light			Red				
16	5	Array Radar Mast			Red				
17	5	Array Radar Mast			White				
18	1	Array Radar Mast			Green				
19	1	Forward searchlight			Clear				

NAVIGATION AND SIGNAL LIGHTS

LOCATION AND OPERATIONAL TEST Hull Number:______

Item #	QTY	Description	Operation	Location	Color		Witnessed by		
			(SAT/UNSAT)	ACTUAL	EXPECTED	ACTUAL	Customer	Shipbuilder	Date
20	1	Bridge wing projector port			Clear				
21	1	Bridge wing projector stbd			Clear				
22	1	Dangerous cargo light			Red				
23	1	Huge vessel light			Green				
24	1	Mimic Panel							

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM

1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE DIAL TELEPHONE SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8660		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 7

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

Demonstrate the proper installation and operation of the Dial Telephone System. Operational tests will prove proper operation of the following equipment:

1.1 One (1) Automatic Dial Telephone System

1.2 One (1) Program Manager Terminal

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, Section N-12.5

2.2 American Bureau of Shipping, Rules Part 4/5.21.2

2.4 IEEE 45-46.2.7

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E401

2.4 Japanese Industrial Standard 8072-86

2.5 Lloyd's Register, Classification of Ships, 6/2/20.2.4 & 6/2/20.6

2.6 IC System Block Wiring Drawing Integrated Interior Communications, Dwg. No. 7250-346-0201

2.7 Tech Manual – Dial Telephone Exchange System

3 TEST INSTRUCTION

3.1 Demonstrate satisfactory operation of the programmable features from the manager terminal IAW reference 2.7. Record all data, as listed, on data sheets provided.

3.2 Demonstrate emergency power supply will maintain system operational for at least thirty (30) minutes. Record data, as listed, on data sheet.

3.3 Demonstrate system can be connected to INMARSAT "B" equipment and configured such that selected telephones can make calls. Record data, as listed, on data sheet.

3.4 Demonstrate each phone circuit has the ability to call in and call out. Where applicable verify special features as noted on data sheets. Record data, as appropriate, on data sheets provided.

DIAL TELEPHONE EXCHANGE Hull Number ______

OPERATIONAL TEST				WITNESSED BY		
Item #	**Description**	**Design**	**Actual**	**Customer**	**Shipbuilder**	**Date**
01	**Manager Terminal**					
	Programming Operations	SAT / UNSAT				
	Simultaneous Conversations	≥ 6				
	Priority Access Set up	SAT / UNSAT				
	Public Address Access Set up	SAT / UNSAT				
	Call Forwarding Set up	SAT / UNSAT				
	Shoreline Access Set up	SAT / UNSAT				
02	**Emergency Power Supply**	≥ 30 Minutes				
03	**INMARSAT B Operations**	SAT / UNSAT				

LEDGEND

TYPE PHONE

B	Surface Mounted (Booth)
D	Desk Mounted
F	Flush Mounted
I	Intrinsically Safe
N	Surface Mounted w/Noise reduction hand set
S	Surface Mounted
HD	Heavy Duty

OPERATION

Norm	Normal Call (Call In / Call Out)
Shore	Ship to Shore Line Access
Priority	Priority Access
Public	Public Address Access
Conf	Group Pick Up (Conference Call)

DIAL TELEPHONE SYSTEM

TYPE, LOCATION VERIFCATION AND OPERATIONAL TEST Hull Number:______

Item #	Phone #	Station	Location	Phone Type	Operations					Witnessed by		
					Norm	Shore	Priority	Public	Conf	Customer	Shipbuilder	Date
04	7101	INS Console	E -- 61 -- 0	F		N/A	N/A					
05	7102	Radio Console	E -- 61 -- 0	F				N/A				
06	7103	Masters Dayroom	D -- 60 -- 1	D								
07	7103	Masters Bedroom	D -- 60 -- 3	D								
08	7104	Chief Engineer Dayroom	D -- 60 -- 2	D								
09	7104	Chief Engineer Bedroom	D -- 60 -- 4	D								
10	7105	Stateroom - Pilot	D -- 56 -- 6	D		N/A	N/A	N/A				
11	7106	Stateroom – Chief Mate	D -- 56 -- 3	D								

DIAL TELEPHONE SYSTEM

TYPE, LOCATION VERIFCATION AND OPERATIONAL TEST													Hull Number:______
Item #	**Phone #**	**Station**	**Location**	**Phone Type**	**Operations**					**Witnessed by**			
					Norm	**Shore**	**Priority**	**Public**	**Conf**	**Customer**	**Shipbuilder**	**Date**	
12	7107	Stateroom – Spare Officer	C -- 56 -- 1	D		N/A	N/A	N/A					
13	7108	Stateroom - 3rd Mate	C -- 60 -- 1	D		N/A	N/A	N/A					
14	7109	Stateroom - 2nd Mate	C -- 60-- 5	D		N/A	N/A	N/A					
15	7110	Stateroom – Spare Officer	C -- 56 -- 2	D		N/A	N/A	N/A					
16	7111	Stateroom – 2nd Ass't Engineer	C -- 60 -- 2	D		N/A	N/A	N/A					
17	7112	Stateroom – 1st Ass't Engineer	C -- 60 -- 6	D									
18	7113	Stateroom – Superintendent	C -- 56 -- 7	D									
19	7114	Stateroom - 3rd Mate	C -- 60 -- 3	D		N/A	N/A	N/A					
20	7115	Stateroom – Spare Officer	C -- 56 -- 8	D		N/A	N/A	N/A					
21	7116	Stateroom – 1st Ass't Engineer	C -- 60 -- 4	D									
22	7117	Stateroom – 3rd Ass't Engineer	C -- 60 -- 0	D		N/A	N/A	N/A					

TYPE, LOCATION VERIFCATION AND OPERATIONAL TEST												Hull Number:______
Item #	**Phone #**	**Station**	**Location**	**Phone Type**	**Operations**					**Witnessed by**		
					Norm	**Shore**	**Priority**	**Public**	**Conf**	**Customer**	**Shipbuilder**	**Date**
23	7149	Emergency Diesel Generator	A -- 38 -- 4	(B)(D) (HD)		N/A	N/A	N/A				
24	7118	Crews Mess	A -- 49 -- 1	S		N/A	N/A	N/A				
25	7119	Officers Mess	A -- 49 -- 2	S		N/A	N/A					
26	7120	Galley	A -- 51 -- 0	(S) (HD)		N/A	N/A	N/A				
27	7121	Crew Lounge / TV Room	A -- 56 -- 1	S		N/A	N/A	N/A				
28	7122	Conference / Interview Room	A -- 56 -- 6	D			N/A					
29	7123	Cargo Control Room	A -- 60 -- 0	F			N/A					
30	7124	Administration Office	A -- 60 -- 1	D								
31	7125	Officers Lounge / TV Room	A -- 60 -- 2	S								
32	7146	Workshop	1 -- 33 -- 2	(S) (HD)		N/A	N/A	N/A				
33	7126	Stewards Office	1 -- 60 -- 6	D			N/A	N/A				
34	7127	Gymnasium	1 -- 49 -- 1	S		N/A	N/A	N/A				
35	7128	Hospital	1 -- 56 -- 6	D		N/A	N/A	N/A				
36	7155	Fire Control Room	1 -- 60 -- 10	(S) (HD)		N/A	N/A	N/A				

TYPE, LOCATION VERIFCATION AND OPERATIONAL TEST											Hull Number:______	
Item #	Phone #	Station	Location	Phone Type	Operations					Witnessed by		
					Norm	Shore	Priority	Public	Conf	Customer	Shipbuilder	Date
34	7129	Bosuns Storeroom	1 -- 151 -- 0	(B)(N) (HD)		N/A	N/A	N/A				
35	7147	Steering Gear Room	2 -- 20 -- 2	(B)(N) (HD)		N/A	N/A	N/A				
36	7148	Steering Gear Room	2 -- 20 -- 1	(B)(N) (HD)		N/A	N/A	N/A				
37	7140	Engine Control Room # 1	2 -- 60 -- 1	F								
38	7141	Engine Control Room # 2	2 -- 60 -- 2	F								
39	7142	HV Room # 1	3 -- 60 -- 5	S		N/A	N/A	N/A				
40	7143	HV Room # 2	3 -- 60 -- 4	S		N/A	N/A	N/A				
41	7144	Machinery Room	5 -- 60 -- 1	(B)(N) (HD)		N/A	N/A	N/A				
42	7145	Machinery Room	5 – 60 -- 2	(B)(N) (HD)		N/A	N/A	N/A				
43	7150	Pump Room	5 -- 61 -- 0	(B)(N) (I)		N/A	N/A	N/A				

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE SOUND POWERED TELEPHONES	
CHECKED		
APPROVED	DRAWING NUMBER	REV
	461-344- 8661	DRAFT
DATE	SCALE: NONE / SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

Demonstrate the proper installation and operation of the Sound Powered Telephone Systems. Operational tests will prove proper operation of the following equipment:

1.1 One (1) 1 JV Sound Powered System

1.2 One (1) 2 JV Sound Powered System

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, Section N-12.4

2.2 American Bureau of Shipping, Rules Part 4/5.21.2

2.4 IEEE 45-46.2.7

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E401

2.4 Japanese Industrial Standard 8072-86

2.5 Lloyd's Register, Classification of Ships, 6/2/20.2.4 & 6/2/20.6

2.6 IC System Block Wiring Drawing Integrated Interior Communications, Dwg. No. 7250-346-0201

3 TEST INSTRUCTION

3.1 Demonstrate satisfactory operation of all stations. Prove ability of each station to call and communicate with all other stations. Record results (Sat or Unsat.) on data sheets provided.

1 JV SOUND POWERED SYSTEM

LEDGEND

Station #	Title	Station #	Title	Station #	Title
1	Wheelhouse Console	5	Fire Control Room	9	Engine Control Rm. # 2
2	Masters Dayroom	6	Stern Lookout	10	Steering Gear Room Stbd
3	Chief Engineer Day Rm.	7	Forecastle Deck Port	11	Steering Gear Room Port
4	Emergency DG Room	8	Engine Control Rm. # 1		
R. BELL = Remote Bell / **DIS** = Disconnect Switch / **HTR** = Heater / **LT** = Light **Design** = SAT / UNSAT					

Item # 01					**OPERATIONAL TEST**									Hull Number:______	
From ⇓	**To ⇒**														
Station #	1	2	3	4	5	6	7	8	9	10	11	R.BELL	DIS	HTR	LT
1	N/A											N/A	N/A	N/A	N/A
2		N/A										N/A	N/A	N/A	N/A
3			N/A									N/A	N/A	N/A	N/A
4				N/A									N/A	N/A	
5					N/A							N/A	N/A	N/A	N/A
6						N/A									N/A
7							N/A								N/A
8								N/A				N/A	N/A	N/A	N/A
9									N/A			N/A	N/A	N/A	N/A
10										N/A			N/A		
11											N/A		N/A		

Witnessed By	
Customer	
Shipbuilder	
Date	

2 JV SOUND POWERED SYSTEM

LEDGEND

Station #	Title	Station #	Title
1	Wheelhouse Console	5	Weather Deck Manifold Port
2	Masters Dayroom	6	Cargo Pump Room
3	Cargo Control Room	7	Engine Control Rm. # 1
4	Weather Deck Manifold Stbd	8	Engine Control Rm. # 2
DIS = Disconnect Switch / **HTR** = Heater / **LT** = Light **Design** = SAT / UNSAT			

Item # 02	**OPERATIONAL TEST**					Hull Number:______		
From ⇓	**To ⇒**							
Station #	1	2	3	4	5	6	7	8
1	N/A							
2		N/A						
3			N/A					
4				N/A				
5					N/A			
6						N/A		
7							N/A	
8								N/A

Witnessed By	
Customer	
Shipbuilder	
Date	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM

1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE RADIO COMMUNICATION EQUIPMENT		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8670		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 2

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

Demonstrate the proper installation and operation of the Radio Communications Equipment. Each Communications system listed shall consist of all equipment/components required for system operation to include antennas, remotes, power supplies, batteries, etc. Operational tests will prove proper operation of the following equipment:

1.1 Three (3) VHF Radio Telephone Systems

1.2 One (1) DSC/HF Telex Terminal, Including Modem, Monitor, CPU, & Printer

1.3 One (1) Satellite Communications System--Std “B” (INMARSAT B)

1.4 One (1) Watch Receiver (2182 kHz)

1.5 One (1) DSC Watch Receiver (2187.5 kHz)

1.6 One (1) MF / HF Transmitter/receiver

1.7 One (1) Satellite Communication System--Std “C” (INMARSAT “C”)

1.8 One (1) Helicopter VHF Radio System

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, Section N-10

2.2 47 CFR Part 80

2.3 American Bureau of Shipping, Rules Part 4/5.21.1

2.4 IEEE 45-46.1

2.5 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E101

2.6 SOLAS-Chapter 4

2.7 Japanese Industrial Standard 8072-86

2.8 Lloyd’s Register, Classification of Ships, 6/2/20.6

3 TEST INSTRUCTION

3.1 The equipment manufacturer will develop test procedures and data sheets required to complete testing and certification of equipment. These test procedures will include both pre-sea trial tests and sea trial tests. In addition a FCC certification will be required.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE SHIP'S WHISTLES		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8671		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 3

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of Ship's whistles. The operational tests will prove proper operation of the following equipment:

1.1 One (1) Air whistle

1.2 One (1) Electric whistle

1.3 One (1) Timer / Controller

1.4 One (1) Port bridge wing At-Will-Control

1.5 One (1) Starboard bridge wing At-Will Control

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section N-6.12

2.2 33 Code of Federal Regulations, Section 86

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E101

2.4 Japanese Industrial Standard 8072-86

2.5 Lloyd's Register, Classification of Ships, 6/2/20.2.6

2.6 American Bureau of Shipping, Rules Part 4/5/21.1

2.7 Tech Manual - Ship's Whistle

3 TEST INSTRUCTION

3.1 Use reference 2.7 as a guide to perform the following steps.

3.2 Demonstrate satisfactory operation of "At-Will" switches listed on the data sheet. Record all data, as listed, on data sheet provided.

3.3 Demonstrate satisfactory automatic operation listed on data sheet. Record data, as appropriate, on data sheet provided.

3.4 Verify heaters are operating as listed on data sheet. Record data, as appropriate, on data sheet provided.

3.5 While sounding the whistle, measure the sound level of the whistle at locations listed on data sheet. Record data, as appropriate, on data sheet provided.

3.6 Demonstrate proper operation of whistle system using general alarm control. Record data, as appropriate, on data sheet provided.

SHIP WHISTLES		OPERATIONAL TEST	Hull Number_______
Item #	**Description**	**Operation**	
		Design	Actual
	At-Will Switches		
1	Int. Nav. Console	SAT/UNSAT	
2	Fwd Bkhd Bridge	SAT/UNSAT	
3	Port Bridge Wing	SAT/UNSAT	
4	Stbd. Bridge Wing	SAT/UNSAT	
	Auto Function		
5	Code # 1	1 prolonged blast @every 2 minutes	
6	Code # 2	2 prolonged blasts w/ about 2 seconds between @ every 2 minutes	
7	Code # 3	1 prolonged, 2 short blasts w/ about 2 seconds between @ every 2 minutes	
8	Code # 4	1 short, 1 prolonged, 1 short blasts w/ about 2 seconds between @ every 1 minute	
9	Electric Whistle Heater	SAT/UNSAT	
10	Air Whistle Heater	SAT/UNSAT	
	Sound Pressure Measurements		
11	Bow Lookout	< 110 dB (A)	
12	Stbd Bridge Wing	< 110 dB (A)	
13	Port Bridge Wing	< 110 dB (A)	
14	Operation from General Alarm System	SAT/UNSAT	

WITNESSED BY		
Customer	Shipbuilder	Date

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM

1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE TANK LEVEL INDICATORS		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8701		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 64

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of tank level indicating systems. The operational tests will prove proper operation of the following equipment:

1.0 One (1) Ship's service remote tank level indicating system

1.0 One (1) Ship's cargo remote tank level indicating system

1.0 One (1) Independent high level alarm system

2 REFERENCES

2.0 1,000,000 bbl Crude Oil Tanker Specification, Sections; C-8.1, H-22.6 and M-1.7.

2.0 Det Norske Veritas, Rules for Classification of Ships, Part 4/4/9/E/101

2.0 Japanese Industrial Standard 8069-86

2.0 Lloyd's Register, Classification of Ships, Part 6/2/20.2.4

2.0 American Bureau of Shipping, Rules Part 4/5/21.1

2.0 Tech Manual - Tank level indicating system

2.0 Sounding Table Drawing

3 TEST INSTRUCTION

3.0 Verify calibration of all tank level indicators and alarms by simulation, in accordance with references 2.6 and 2.7. Record data on data sheets provided.

3.0 The data sheet for each individual tank is subdivided into as many as four tables. The tables represent (1) Tank level verification, (2) Temperature sensing, (3) Inert gas pressure and (4) Hi /Hi level alarm set points. Only the tables required for each specific tank will be displayed on the corresponding data sheets.

3.0 Prove tank level indicator readings by manually sounding all tanks using sounding tape. Adjust readings for trim and list of ship. Correct sounding tape readings to volume using tank tables. Record data, as appropriate, on data sheets. Readings should be taken at a point between 20% and 60% full capacity of tank. Accuracy shall be within ±6% of each other. These readings may be taken during sea trials.

Tank Name: Cargo Oil Tank # 1, Stbd.

ITEM # ______			**LEVEL OF TANK**										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Shipbuilder	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	**HI / HI LEVEL ALARM @ 98 %**		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Shipbuilder	Date

ITEM # _______	**TEMPERATURE OF TANK**			
	LOCAL PANEL		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	Shipbuilder	Date

ITEM # _______	**CALIBRATION**		**INERT GAS PRESSURE**			
	INITIAL@XDUCER		**LOCAL PANEL**		**MCCS**	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	Shipbuilder	Date

Tank Name: Cargo Oil Tank # 1, Center

ITEM # ______			LEVEL OF TANK									
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	**HI / HI LEVEL ALARM @ 98 %**		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	**TEMPERATURE OF TANK**			
	LOCAL PANEL		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM # ______	**CALIBRATION**		**INERT GAS PRESSURE**			
	INITIAL@XDUCER		**LOCAL PANEL**		**MCCS**	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Cargo Oil Tank # 1, Port

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # _______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM # _______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Cargo Oil Tank # 2, Stbd.

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM # ______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Cargo Oil Tank # 2, Center

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM # ______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Cargo Oil Tank # 2, Port

ITEM # ______			**LEVEL OF TANK**										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	**HI / HI LEVEL ALARM @ 98 %**		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	**TEMPERATURE OF TANK**			
	LOCAL PANEL		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM # ______	**CALIBRATION**		**INERT GAS PRESSURE**			
	INITIAL@XDUCER		**LOCAL PANEL**		**MCCS**	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Cargo Oil Tank # 3, Stbd.

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM # ______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Cargo Oil Tank # 3, Center

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM # ______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Cargo Oil Tank # 3, Port

ITEM #		LEVEL OF TANK											
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#_______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM #	TEMPERATURE OF TANK			
_______	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM #	CALIBRATION		INERT GAS PRESSURE			
_______	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Cargo Oil Tank # 4, Stbd.

ITEM #			**LEVEL OF TANK**										
______	**CALIBRATION**		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	**HI / HI LEVEL ALARM @ 98 %**		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM #	**TEMPERATURE OF TANK**			
_______	**LOCAL PANEL**		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM #	**CALIBRATION**		**INERT GAS PRESSURE**			
_______	INITIAL@XDUCER		**LOCAL PANEL**		**MCCS**	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Cargo Oil Tank # 4, Center

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM # ______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Cargo Oil Tank # 4, Port

ITEM # ______			**LEVEL OF TANK**										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	**HI / HI LEVEL ALARM @ 98 %**		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # _______	**TEMPERATURE OF TANK**			
	LOCAL PANEL		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM # _______	**CALIBRATION**		**INERT GAS PRESSURE**			
	INITIAL@XDUCER		**LOCAL PANEL**		**MCCS**	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Cargo Oil Tank # 5, Stbd.

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM # ______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Cargo Oil Tank # 5, Center

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM # ______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Cargo Oil Tank # 5, Port

ITEM # ______			**LEVEL OF TANK**										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	**HI / HI LEVEL ALARM @ 98 %**		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	**TEMPERATURE OF TANK**			
	LOCAL PANEL		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM # ______	**CALIBRATION**		**INERT GAS PRESSURE**			
	INITIAL@XDUCER		**LOCAL PANEL**		**MCCS**	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Cargo Oil Tank # 6, Stbd.

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM # ______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Cargo Oil Tank # 6, Center

ITEM # ______		LEVEL OF TANK											
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # _______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM # _______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Cargo Oil Tank # 6, Port

ITEM #			**LEVEL OF TANK**										
_______	**CALIBRATION**		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	**HI / HI LEVEL ALARM @ 98 %**		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM #	**TEMPERATURE OF TANK**			
_______	**LOCAL PANEL**		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM #	**CALIBRATION**		**INERT GAS PRESSURE**			
_______	INITIAL@XDUCER		**LOCAL PANEL**		**MCCS**	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Slop Tank, Stbd

ITEM # _______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#_______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # _______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

ITEM # _______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						
		WITNESS				
		Customer	NASSCO	Date		

Tank Name: Slop Tank, Port

ITEM # _______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#_______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # _______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

ITEM # _______	CALIBRATION		INERT GAS PRESSURE			
	INITIAL@XDUCER		LOCAL PANEL		MCCS	
% of Scale	PRESSURE (PSI)	CURRENT (MA)	EXPECTED (PSI)	ACTUAL (PSI)	EXPECTED (PSI)	ACTUAL (PSI)
0 %						
25 %						
50 %						
75 %						
100 %						
Lo Alm						
Hi Alm						

WITNESS		
Customer	NASSCO	Date

Tank Name: Forepeak Tank

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: # 1 WB J-Tank, Stbd

ITEM # _______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: # 1 WD J-Tank, Port

ITEM #			**LEVEL OF TANK**										
_______	**CALIBRATION**		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: # 2 WD J-Tank, Stbd.

ITEM # _______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: # 2 WD J-Tank, Port

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: # 3 WB U-Tank, Stbd. & Port

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: # 4 WB U-Tank, Stbd. & Port

ITEM # _______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Task Name #5 WB U-Tank, Stbd. & Port

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: # 6 WB J-Tank, Stbd.

<table>
<tr><td>ITEM #
_______</td><td colspan="2"></td><td colspan="8">LEVEL OF TANK</td><td colspan="3"></td></tr>
<tr><td></td><td colspan="2">CALIBRATION</td><td colspan="4">LOCAL PANEL</td><td colspan="4">MCCS</td><td colspan="3">WITNESS</td></tr>
<tr><td></td><td colspan="2">INITIAL@XDUCER</td><td colspan="2">EXPECTED</td><td colspan="2">ACTUAL</td><td colspan="2">EXPECTED</td><td colspan="2">ACTUAL</td><td>Customer</td><td>Nassco</td><td>Date</td></tr>
<tr><td>% in Height</td><td>PRESSURE (PSI)</td><td>CURRENT (MA)</td><td>HT (Meters)</td><td>Vol. (M Ton)</td><td>HT (Meters)</td><td>Vol. (M Ton)</td><td>HT (Meters)</td><td>Vol. (M Ton)</td><td>HT (Meters)</td><td>Vol. (M Ton)</td><td></td><td></td><td></td></tr>
<tr><td>0 %</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>25 %</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>50 %</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>75 %</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>100 %</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Lo Alm</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hi Alm</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Tank Name: # 6 WD J-Tank, Port

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: Aft Peak Tank

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name:..# 1 HFO Storage Tank

ITEM # ______		LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	**HI / HI LEVEL ALARM @ 98 %**		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	**TEMPERATURE OF TANK**			
	LOCAL PANEL		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name:..# 2 HFO Storage Tank

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name:..# 3 HFO Storage Tank

ITEM # _______		LEVEL OF TANK											
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#_______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # _______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name:..# 4 HFO Storage Tank

ITEM # ______		LEVEL OF TANK											
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # ______	**TEMPERATURE OF TANK**			
	LOCAL PANEL		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				
	WITNESS			
	Customer	NASSCO	Date	

Tank Name: HFO Overflow Tank, Stbd.

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: HFO Service Tank # 1

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: LSHFO Storage Tank , Stbd.

ITEM # _______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#_______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

ITEM # _______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: LSHFO Service Tank , Stbd.

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: LSHFO Settling Tank, Stbd.

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		**MCCS**	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: MDO Service Tank, Stbd.

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: MDO Storage Tank, Port

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

IT#______	HI / HI LEVEL ALARM @ 98 %		
	EXPECTED	ACTUAL	
CCR	SAT/UNSAT		
Deck Light	SAT/UNSAT		
Deck Horn	SAT/UNSAT		
WITNESS	Customer	Nassco	Date

Tank Name: HFO Overflow Tank, Port

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: HFO Service Tank # 2

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM #	TEMPERATURE OF TANK			
_______	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: HFO Settling Tank

ITEM # _______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM # _______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: LSHFO Service Tank, Port

ITEM # ______			LEVEL OF TANK											
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: DG Lube Oil Storage Tank, Stbd.

ITEM # _______			LEVEL OF TANK										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: DG Lube Oil Settling Tank, Stbd.

ITEM # ______			LEVEL OF TANK										
	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM # ______	TEMPERATURE OF TANK			
	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: DG Lube Oil Storage Tank, Port

ITEM # _______			**LEVEL OF TANK**										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: DG Lube Oil Settling Tank, Port

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM #	TEMPERATURE OF TANK			
_______	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: Portable Water Tank, Stbd.

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: Potable Water Tank, Port

ITEM #			**LEVEL OF TANK**										
_______	**CALIBRATION**		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: Cascade Tank, Port

ITEM # ______			**LEVEL OF TANK**										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: Cascade Tank, Stbd.

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: Rdcn Gear Lube Oil Storage Tank, Port

ITEM #		LEVEL OF TANK											
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM #	TEMPERATURE OF TANK			
_______	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: Rdcn Gear Lube Oil Storage Tank, Stbd.

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)	HT (Meters)	Vol. (Gals)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

ITEM #	TEMPERATURE OF TANK			
_______	LOCAL PANEL		MCCS	
% of Scale	EXPECTED (°C)	ACTUAL (°C)	EXPECTED (°C)	ACTUAL (°C)
0 %				
25 %				
50 %				
75 %				
100 %				
Lo Alm				
Hi Alm				

WITNESS		
Customer	NASSCO	Date

Tank Name: Distilled Water Tank, Stbd.

ITEM # ______			**LEVEL OF TANK**										
	CALIBRATION		**LOCAL PANEL**				**MCCS**				**WITNESS**		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: Distilled Tank, Port

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)	HT (Meters)	Vol. (M Ton)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

Tank Name: Emergency Diesel Generator Diesel Oil Tank

ITEM #			LEVEL OF TANK										
_______	CALIBRATION		LOCAL PANEL				MCCS				WITNESS		
	INITIAL@XDUCER		EXPECTED		ACTUAL		EXPECTED		ACTUAL		Customer	Nassco	Date
% in Height	PRESSURE (PSI)	CURRENT (MA)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)	HT (Meters)	Vol. (Barrels)			
0 %													
25 %													
50 %													
75 %													
100 %													
Lo Alm													
Hi Alm													

COMPARISON BETWEEN TLI SYSTEM AND SOUNDING TAPE READINGS											
Item #	**Tank Name**	**Remote Tank**		**Sounding Tape**			**% Difference**		**Witness**		
		Level Indicator		Actual	Adjusted	Converted					
		Meters	Volume	Meters	Meters	Volume	%	Sat/Unsat	Customer	Nassco	Date
	Cargo Oil Tank # 1, Stbd.										
	Cargo Oil Tank # 1, Center										
	Cargo Oil Tank # 1, Port										
	Cargo Oil Tank # 2, Stbd.										
	Cargo Oil Tank # 2, Center										
	Cargo Oil Tank # 2, Port										
	Cargo Oil Tank # 3, Stbd.										
	Cargo Oil Tank # 3, Center										
	Cargo Oil Tank # 3, Port										
	Cargo Oil Tank # 4, Stbd.										
	Cargo Oil Tank # 4, Center										
	Cargo Oil Tank # 4, Port										
	Cargo Oil Tank # 5, Stbd.										
	Cargo Oil Tank # 5, Center										
	Cargo Oil Tank # 5, Port										
	Cargo Oil Tank # 6, Stbd.										
	Cargo Oil Tank # 6, Center										
	Cargo Oil Tank # 6, Port										
	Slop Tank, Stbd.										
	Slop Tank, Port										
	Forepeak Tank										
	#1 WB J-Tank, Stbd.										
	#1 WB J-Tank, Port										

COMPARISON BETWEEN TLI SYSTEM AND SOUNDING TAPE READINGS												
Item #	**Tank Name**	**Remote Tank Level Indicator**		**Sounding Tape**			**% Difference**		**Witness**			
				Actual	Adjusted	Converted						
		Meters	Volume	Meters	Meters	Volume	%	Sat/Unsat	Customer	Nassco	Date	
	#2 WB J-Tank, Stbd.											
	#2 WB J-Tank, Port											
	#3 WB U-Tank,Stbd.&Port											
	#4 WB U-Tank,Stbd.&Port											
	#5 WB U-Tank,Stbd&Port											
	#6 WB J-Tank, Stbd.											
	#6 WB J-Tank, Port											
	Aft Peak Tank											
	#1 HFO Storage Tank											
	#2 HFO Storage Tank											
	#3 HFO Storage Tank											
	#4 HFO Storage Tank											
	HFO Overflow Tank, Stbd.											
	HFO Service Tank # 1											
	LSHFO Storage Tank, Stbd.											
	LSHFO Service Tank, Stbd.											
	LSHFO Settling Tank,Stbd.											
	MDO Service Tank, Stbd.											
	MDO Storage Tank, Port											
	HFO Overflow Tank, Port											
	HFO Service Tank, # 2											
	HFO Settling Tank											
	LSHFO Service Tank, Port											

COMPARISON BETWEEN TLI SYSTEM AND SOUNDING TAPE READINGS											
Item #	**Tank Name**	**Remote Tank Level Indicator**		**Sounding Tape**			**% Difference**		**Witness**		
				Actual	Adjusted	Converted					
		Meters	Volume	Meters	Meters	Volume	%	Sat/Unsat	Customer	Nassco	Date
	DG LO Storage Tank, Stbd.										
	DG LO Settling Tank, Stbd.										
	DG LO Storage Tank, Port										
	DG LO Settling Tank, Port										
	Portable Water Tank, Stbd.										
	Portable Water Tank, Port										
	Cascade Tank, Port										
	Cascade Tank, Stbd.										
	Rdcn Gear LO Storage Tank, Port										
	Rdcn Gear LO Storage Tank, Stbd.										
	Distilled Water Tank, Stbd.										
	Distilled Water Tank, Port										
	Emerg. DG DO Tank										

COMPARISON BETWEEN TLI SYSTEM AND SOUNDING TAPE READINGS											
Item #	**Tank Name**	**Remote Tank Level Indicator**		**Sounding Tape**			**% Difference**		**Witness**		
				Actual	Adjusted	Converted					
		Meters	Volume	Meters	Meters	Volume	%	Sat/Unsat	Customer	Nassco	Date

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE AUXILIARY BOILER AND SERVICES		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8715		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 7

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the auxiliary boiler and associated services. The operational test of the unit will prove proper operation of the following equipment:

1.1 Two (2) auxiliary combination boilers and associated burner, combustion air, and atomiser units, and controls

1.2 Four (4) HFO supply pumps

1.3 Two (2) DO supply pumps

1.4 Two (2) fuel oil steam heaters

1.5 Four (4) boiler feedwater pumps

1.6 Two (2) chemical injection systems

1.7 Two (2) feedwater regulating valves

1.8 Two (2) feedwater recirculating valves

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 46Code of Federal Regulations, Sections 52.01-135, 61.10, 61.35

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/3-46

2.4 Lloyd’s Register, Classification of Ships, Parts 5/10.17 and 5/1.1.1

2.5 American Bureau of Shipping, Sections 4/6.7.2, and 4/6.7.8

2.6 Combination Boiler Feedwater System Diagram, Dwg. No. 7250-342-7120 Rev. -

2.7 Tech Manual - Vertical oil fired/exhaust gas fired composite boiler

3 TEST INSTRUCTION

3.1 Perform a hydrostatic pressure test on each auxiliary boiler. The hydrostatic test pressure is to be 1.5 times working pressure as indicated on the data sheets. The water used for hydrostatic testing shall be between 70°F and 160°F. The boiler safety valves shall be secured with a clamp or gagging device. Hydrostatic pressure is to be applied for a sufficient length of time necessary to conduct a visual examination for leakage.

3.2 Align the auxiliary boiler feedwater pumps and demonstrate the pumps’ ability to take suction from the cascade tank and discharge to the boiler. Record data, as appropriate, on data sheets provided.

3.3 Demonstrate the proper operaton of feed system relief valves and verify set points. Record data, as appropriate, on data sheets provided.

3.4 Align the auxiliary boiler for normal operation, and prove the boiler’s ability to produce steam in the oil fired mode. Prove that the combustion controls are stable and operate smoothly. Demonstrate start-up seqeunce, manual operation, automatic operation, remote controls, programming controls and fuel supply controls. Demonstrate proper operation of associated equipment, blowers, fuel pumps, smoke density meters, as listed on data sheets. Record all operating data, as listed, on data sheets provided.

3.5 Demonstrate operation of the steam dump backpressure control valve. Record data, as appropriate, on data sheets provided.

3.6 Test the boiler safety valves to prove proper manual operation, and to verify set point pressures. Record data, as appropriate, on data sheets provided.

3.7 Demonstrate the following automatic trips and alarms that are associated with the control panel for the auxiliiary boiler:

3.7.1 Safety (programming) controls
3.7.2 Flame safeguard
3.7.3 Fuel supply controls
3.7.4 Fuel oil pressure limit control
3.7.5 Fuel oil temperature limit control
3.7.6 Combustion controls
3.7.7 Draft limit control
3.7.8 Limit controls
3.7.9 Water level controls
3.7.10 Feedwater flow controls
3.7.11 Low voltage test
3.7.12 Switches.

3.8 Demonstrate the feedwater regulator’s ability to maintain an normal working level in the boiler. Record all operating data, as listed, on data sheets provided.

3.9 Demonstrate the proper operation of the feedwater recirculating valves. Record all operating data, as listed, on data sheets provided.

3.10 Prove proper operation of the soot blowing equipment. Record all operating data, as listed, on data sheets provided.

3.11 Demonstrate proper operation of the chemical injection system. Record all operating data, as listed, on data sheets provided.

3.12 Demonstrate proper operation of the cascade tank make-up feed valve. Record data, as appropriate, on data sheets provided.

Auxiliary Boiler Feedwater Pumps Hull Number:______

OPERATIONAL TEST						
Item #	**Description**	**Design**	**Actual**			
			Port		Starboard	
			Pump #2	Pump #4	Pump #1	Pump #3
1	**MOTOR**					
	Volts:	460				
	Amps: Phase A	<15				
	Amps: Phase B	<15				
	Amps: Phase C	<15				
	Rotation:	SAT/ UNSAT				
	RPM:	1800				
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
	Bearing Temp:	SAT/ UNSAT				
	Frame Temp:	SAT/ UNSAT				
2	**CONTROLLER**					
	Cold Insulation Resistance:	>1MΩ				
	Hot Insulation Resistance:	>1MΩ				
3	**PUMP**					
	Syst. Design Disch Press:	225 psi				
	Syst. Design Suct. Press:	5- 20 psi				
	Relief Valve setting	235 psi (±3 psi)				
	Bearing Temp:	SAT/ UNSAT				
4	**OBSERVATIONS**					
	Noise:	SAT/ UNSAT				
	Vibration:	SAT/ UNSAT				
	Casing Temp:	SAT/ UNSAT				
	Leakage:	SAT/ UNSAT				
	Lubrication:	SAT/ UNSAT				

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

AUXILIARY BOILER OPERATIONAL TEST					Hull Number:______	
Item #	**Description**	**Design**	**Actual**			
			Port		**Starboard**	
	AUXILIARY BOILER OPERATION					
1	Hydrostatic test at 1.5 times working pressure (10.5 bar)	No leakage				
	Operation of combustion controls	SAT/UNSAT				
	Operation of fuel supply controls	SAT/UNSAT				
	Operation of start-up sequence	SAT/UNSAT				
	Satisfactory manual operation	SAT/UNSAT				
	Satisfactory automatic operation	SAT/UNSAT				
	Operation of heavy fuel oil supply pump	4 bar				
	Operation of diesel oil supply pump	4 bar				
	Operation of rotary atomiser burner unit	SAT/UNSAT				
	Operation of combustion air fan	SAT/UNSAT				
	Operation of steam dump backpressure control valve	SAT/UNSAT				
	Boiler safety valve manual operation	SAT/ UNSAT				
	Boiler safety valve set point verification	SAT/UNSAT				
	Operation of smoke density meter	SAT/UNSAT				
	Operation of sootblowing equipment	SAT/UNSAT				
	FEEDWATER SYSTEM		**#2**	**#4**	**#1**	**#3**
2	Ability of feedwater pumps to deliver water to boiler from cascade tank	SAT/ UNSAT				
3	Feedwater pump relief valve setpoint verification	SAT/UNSAT				
	Feedwater regulator maintains normal working level	SAT/ UNSAT				
	Operation of feedwater recirculating valve	SAT/ UNSAT				
	Operation of chemical injection system	SAT/ UNSAT				
	Ooperation of cascade tank make-up feed valve	SAT/ UNSAT				
	SAFETY SHUTDOWNS					
	Safety (programming) controls	SAT/UNSAT				
8	Flame safeguard (flame and ignition failure)	SAT/UNSAT				
	Fuel supply controls	SAT/UNSAT				
9	Fuel oil pressure limit control	55 psig (±5psig)				

AUXILIARY BOILER OPERATIONAL TEST			Hull Number:______	
Item #	**Description**	**Design**	**Actual**	
10	Fuel oil temperature limit control	SAT/UNSAT		
	Combustion controls	SAT/UNSAT		
	Draft limit control	SAT/UNSAT		
	Limit controls	SAT/UNSAT		
	Water level controls	SAT/UNSAT		
	Feedwater flow controls	SAT/UNSAT		
11	Low voltage test	SAT/UNSAT		
12	Switches	SAT/UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

SLUDGE TRANSFER SYSTEM - OPERATIONAL TEST			Hull Number:______
Item #	**Description**	**Design**	**Actual**
18	Ability of #1 sludge transfer pump to take suction from:		
	Oil sludge tank	SAT/ UNSAT	
	Waste oil tank	SAT/ UNSAT	
	FO Fill and Transfer System	SAT/ UNSAT	
19	Ability of #1 sludge transfer pump to discharge to:		
	Dirty slop tank (via cargo system)	SAT/ UNSAT	
	Waste oil tank	SAT/ UNSAT	
	Sludge day tank	SAT/ UNSAT	
20	Ability of #2 sludge transfer pump to take suction from:		
	Oil sludge tank	SAT/ UNSAT	
	Waste oil tank	SAT/ UNSAT	
	FO Fill and Transfer System	SAT/ UNSAT	
21	Ability of #2 sludge transfer pump to discharge to:		
	Dirty slop tank (via cargo system)	SAT/ UNSAT	
	Waste oil tank	SAT/ UNSAT	
	Sludge day tank	SAT/ UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM

1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE FIRE AND FOAM SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8717		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 5

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
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1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the fire and foam system. The operational test of the system will prove proper operation of the following equipment:

1.1 Two (2) fire / general service pumps

1.2 One (1) foam liquid supply pump

1.3 One (1) foam storage tank

1.4 One (1) foam proportioner

1.5 Eight (8) foam monitors

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Sections 4/6.7.8, and 4/9.7.2

2.3 46 CFR 95.10-5, and 76.23

2.4 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.5 Navigation and Vessel Inspection Circulars 6-72, Guide to Fixed Fire-fighting Equipment Aboad Merchant Vessels

2.6 Fire and Foam System Diagram, Dwg. No. 7250-342-7102

3 TEST INSTRUCTION

3.1 Align the firemain system for normal operation, and operate each fire/general service pump for 10 minutes to obtain system design conditions. Prove proper operation of relief valves, automatic controls, and interlocks. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Demonstrate the ability of the firemain system to discharge to all sub-system service branches as indicated on the associated data sheet including: Water spray system, water deluge system, anchor chain washdown system, inert gas scrubber, pump room eductors, and all interior and exterior hydrants. Record all operating data, as listed, on data sheets provided.

3.3 Demonstrate the system's ability to deliver simultaneous streams of water from the furthest two hydrants. Using a pitot gauge, measure the pressure at each hydrant. Record data, as listed, on data sheets provided.

3.4 Demonstrate the ability of the No. 2 fire/general service pump to deballast the aft peak tank. Record data, as listed, on data sheets provided.

3.5 Demonstrate proper operation of the foam system including the foam liquid supply pump, foam storage tank, foam monitors, and foam proportioner. Operate foam liquid supply pump for 10 minutes, and record all operating data, as listed, on data sheets provided. Foam coverage, monitor operation, and foam station pressure readings will be accomplished using seawater.

Note: The emergency bilge suctions via the seawater system will be demonstrated as part of Test Procedure 8722 - Machinery Bilge and Oily Waste Transfer System

Fire / General Service Pumps Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
1	**MOTOR**			
	Volts:	460		
	Amps: Phase A	<28		
	Amps: Phase B	<28		
	Amps: Phase C	<28		
	Rotation:	SAT/ UNSAT		
	RPM:	1760		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
2	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
3	**PUMP**			
	Syst. Design Disch Press:	115 - 122 psi		
	Syst. Design Suct. Press:	0 - 5 psi		
	Relief Valve setting	125 psi (±3 psi)		
	Bearing Temp:	SAT/ UNSAT		
4	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp:	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Foam Liquid Supply Pump Hull Number:______

OPERATIONAL TEST			
Item #	**Description**	**Design**	**Actual**
5	**MOTOR**		
	Volts:	460	
	Amps: Phase A	<12	
	Amps: Phase B	<12	
	Amps: Phase C	<12	
	Rotation:	SAT/ UNSAT	
	RPM:	1800	
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Bearing Temp:	SAT/ UNSAT	
	Frame Temp:	SAT/ UNSAT	
6	**CONTROLLER**		
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
7	**PUMP**		
	Syst. Design Disch Press:	50 - 65	
	Syst. Design Suct. Press:	0 - 5 psi	
	Relief Valve setting	70 psi (±3 psi)	
	Bearing Temp:	SAT/ UNSAT	
8	**OBSERVATIONS**		
	Noise:	SAT/ UNSAT	
	Vibration:	SAT/ UNSAT	
	Casing Temp:	SAT/ UNSAT	
	Leakage:	SAT/ UNSAT	
	Lubrication:	SAT/ UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Fire and Foam System Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
	FIREMAIN SYSTEM			
9	Pump starts and stops locally	SAT/ UNSAT		
10	Ability of pump to deliver two simultaneous streams of water from the furthest two hydrants.	(115 psi) (Pitot gauge reading)		
11	Ability of No. 2 fire/general service pump to deballast aft peak tank	SAT/ UNSAT	N/A	
12	Operation of pump room eductors	SAT/ UNSAT		
	FIRE CONTROL STATION			
13	Abilty to start/stop fire / general service pumps	SAT/ UNSAT		
14	Firemain header pressure indication	SAT/ UNSAT		
15	Foam system actuation	SAT/ UNSAT		
	WATER SPRAY SYSTEM			
16	Ability to spray bridge windows and accommodation front and side walls	SAT/ UNSAT		
	Operation of water spray master release valves from:			
17	Fire Control Station	SAT/ UNSAT		
18	Ship's automation system	SAT/ UNSAT		
19	Local manual operation	SAT/ UNSAT		
	WATER DELUGE SYSTEM			
20	Ability to provide overhead water protection to lifeboat embarkation areas.	SAT/ UNSAT		
	Operation of water spray master release valves from:			
21	Fire Control Station	SAT/ UNSAT		
22	Local manual operation near lifeboats	SAT/ UNSAT		
	CARGO DECK FOAM SYSTEM			
23	Operation of monitor isolation valves from Fire Control Station	SAT/ UNSAT		
24	Verify foam coverage from monitors (using sea water)	SAT/ UNSAT		
25	Pressure reading at foam station	(55 - 65 psi) (Pitot gauge reading)		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE MACHINERY BILGE AND OILY WASTE TRANSFER SYSTEM	
CHECKED		
APPROVED	DRAWING NUMBER	REV
	461-344- 8722	DRAFT
DATE	SCALE: NONE / SIZE: A	SHEET 1 OF 7

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the machinery bilge and oily waste transfer system. The operational test of the system will prove proper operation of the following equipment:

1.1 One (1) bilge oily water separator, with oil content monitor

1.2 One (1) separator pump, integral with OWS

1.3 Two (2) bilge housekeeping pumps

1.4 Two (2) main bilge pumps (deepwell)

1.5 Two (2) bilge water holding tanks

1.6 One (1) forward bilge transfer pump

1.7 Two (2) emergency bilge suctions (from the seawater cooling system)

1.8 Two (2) independent bilge suctions (from the firemain)

1.9 One (1) chain locker eductor

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section M-5.8, M-8.0, and C-12.0

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Lloyd's Register, Classification of Ships, Rules and Regulations, Part 3/1.8.3.8

2.5 Bilge System Diagram, Dwg. No. 7250-342-7110 Rev. A

2.6 Oil/Water Separator tech manual

3 TEST INSTRUCTION

3.1 Align main bilge pumps for bilge dewatering, and operate each pump for 10 minutes to obtain system design conditions. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Align the secondary independent bilge suction for bilge dewatering, using the fire/general service pumps, and demonstrate the pumps ability to dewater the bilge well Record data, as appropriate, on data sheets provided. Note: Complete operational testing of fire/general service pumps will be included in the Firemain Test Procedure.

3.3 Align the emergency bilge suction for bilge dewatering, using the seawater cooling pumps, and demonstrate the pumps ability to dewater the bilge well Record data, as appropriate, on data sheets provided. Note: Complete operational testing of seawater cooling pumps will be included in the Seawater Cooling Test Procedure.

3.4 Align the bilge housekeeping pumps for normal operation, and operate each pump for 10 minutes to obtain system design conditions. Demonstrate the pumps ability to take suction from each suction connection, and discharge to each discharge connection. Record all operating data, as listed, on data sheets provided. Design data not shown on the data

sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.5 Align the forward bilge transfer pump for dewatering, and demonstrate the pump's ability to dewater the forward bilge wells. Record data, as appropriate, on data sheets provided.

3.6 Align the chain locker eductor for dewatering, and demonstrate the eductor's ability to dewater the chain locker. Record data, as appropriate, on data sheets provided.

3.7 Align the oil/water separator for normal operation, and operate for 10 minutes to obtain system design conditions. Demonstrate proper system operation. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

Main Bilge Pumps (Deepwell) Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
1	**MOTOR**			
	Volts:	460		
	Amps: Phase A	<22		
	Amps: Phase B	<22		
	Amps: Phase C	<22		
	Rotation:	SAT/ UNSAT		
	RPM:	1780		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
2	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
3	**PUMP**			
	Syst. Design Disch Press:	65 - 90 psi		
	Syst. Design Suct. Press:	0 - 28” hg. vac		
	Bearing Temp:	SAT/ UNSAT		
4	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp.	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Bilge Housekeeping Pumps Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
5	**MOTOR**			
	Volts:	460		
	Amps: Phase A	<12		
	Amps: Phase B	<12		
	Amps: Phase C	<12		
	Rotation:	SAT/ UNSAT		
	RPM:	1780		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
6	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
7	**PUMP**			
	Syst. Design Disch Press:	65 - 90 psi		
	Syst. Design Suct. Press:	0 - 28” hg. vac		
	Bearing Temp:	SAT/ UNSAT		
8	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp.	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Oil/Water Separator Hull Number:______

OPERATIONAL TEST			
Item #	**Description**	**Design**	**Actual**
9	**PUMP MOTOR**		
	Volts:	460	
	Amps:	<10	
	Rotation:	SAT/ UNSAT	
	RPM:	660	
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Bearing Temp:	SAT/ UNSAT	
	Frame Temp:	SAT/ UNSAT	
10	**CONTROLLER**		
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
11	**PUMP**		
	Syst. Design Disch Press:	15 - 25 psi	
	Syst. Design Suct. Press:	0 - 5 psi	
	Bearing Temp:	SAT/ UNSAT	
12	**OIL WATER SEPARATOR**		
	Operation IAW tech manual	SAT/ UNSAT	
	Oil/water separator monitor operation / overboard discharge	SAT/ UNSAT	
	Alarms and safeties	SAT/ UNSAT	
	Suction and recirculation to and from bilge water tank	SAT/ UNSAT	
	Oil discharge to waste oil tank	SAT/ UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Machinery Bilge and Oily Water Separator System Hull Number:______

OPERATIONAL TEST			
Item #	**Description**	**Design**	**Actual**
13	Ability of secondary independent bilge suction to dewater bilge well (#1 fire/general service pump)	45-60 psi	
14	Ability of emergency bilge suction to dewater bilge well (#1 seawater cooling pump)	45-60 psi	
15	Ability of #1 bilge housekeeping pump to take suction from:		
	main bilge well	SAT/ UNSAT	
	aft bilge well	SAT/ UNSAT	
	innerbottom voids	SAT/ UNSAT	
	bilge water holding tank	SAT/ UNSAT	
16	Ability of #1 bilge housekeeping pump to discharge to:		
	bilge water holding tank	SAT/ UNSAT	
	Port and Stbd. shore connections	SAT/ UNSAT	
17	Ability of #2 bilge housekeeping pump to take suction from:		
	main bilge well	SAT/ UNSAT	
	aft bilge well	SAT/ UNSAT	
	innerbottom voids	SAT/ UNSAT	
	bilge water holding tank	SAT/ UNSAT	
18	Ability of #2 bilge housekeeping pump to discharge to:		
	bilge water holding tank	SAT/ UNSAT	
	Port and Stbd. shore connections	SAT/ UNSAT	
19	Ability of forward bilge transfer pump to dewater forward bilge wells	SAT/ UNSAT	
20	Ability of chain locker eductor to dewater chain locker	SAT/ UNSAT	
21	Proper operation of steering gear sump gravity drain #1	SAT/ UNSAT	
22	Proper operation of steering gear sump gravity drain #2	SAT/ UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE POTABLE WATER SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8725		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 5

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the potable water system. The operational test of the system will prove proper operation of the following equipment:

1.1 One (1) hydropneumatic tank

1.2 Two (2) storage tanks

1.3 Two (2) fresh water potable pumps

1.4 One (1) electric calorifier unit (hot water heater)

1.5 One (1) hot water circ pump

1.6 One (1) re-hardening filter

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Potable Water Pumping System Diagram, Dwg. No. 7250-342-7131

2.5 Re-hardening filter tech manual

3 TEST INSTRUCTION

3.1 Align system for normal operation, and operate each pump for 30 minutes to obtain system design conditions. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Demonstrate proper operation of relief valves, automatic controls, and filter. Demonstrate the ability of the system to supply hot and cold water to the highest and farthest outlets. Record all operating data, as listed, on data sheets provided.

Fresh Water Potable Pumps Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			Pump #1	Pump #2
1	**MOTOR**			
	Volts:	460		
	Amps: Phase A	<15		
	Amps: Phase B	<15		
	Amps: Phase C	<15		
	Rotation:	SAT/ UNSAT		
	RPM:	1780		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
2	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
3	**PUMP**			
	Syst. Design Disch Press:	65 - 90 psi		
	Syst. Design Suct. Press:	0-10 psi		
	Bearing Temp:	SAT/ UNSAT		
4	**OBSERVATIONS**			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp.	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Hot Water Circulating Pump Hull Number:______

OPERATIONAL TEST			
Item #	**Description**	**Design**	**Actual**
5	**MOTOR**		
	Volts:	460	
	Amps: Phase A	<8	
	Amps: Phase B	<8	
	Amps: Phase C	<8	
	Rotation:	SAT/ UNSAT	
	RPM:	1760	
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Bearing Temp:	SAT/ UNSAT	
	Frame Temp:	SAT/ UNSAT	
6	**CONTROLLER**		
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
7	**PUMP**		
	Syst. Design Disch Press:	15-25 psi	
	Syst. Design Suct. Press:	0-5 psi	
	Bearing Temp:	SAT/ UNSAT	
8	**OBSERVATIONS**		
	Noise:	SAT/ UNSAT	
	Vibration:	SAT/ UNSAT	
	Casing Temp.	SAT/ UNSAT	
	Leakage:	SAT/ UNSAT	
	Lubrication:	SAT/ UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

Potable Water System Hull Number:______

OPERATIONAL TEST			
Item #	**Description**	**Design**	**Actual**
9	Pump #1 - Ability to take suction from both tanks	SAT/ UNSAT	
10	Pump #2 - Ability to take suction from both tanks	SAT/ UNSAT	
11	Hydrophore tank relief valve setting	110 psi (+0/-2 psi)	
12	Hot water heater operation - outlet temp	145°F (±3°F)	
13	Water to highest outlet (Location:__________)	SAT/ UNSAT	
14	Water to farthest outlet (Location:__________)	SAT/ UNSAT	
15	Operation of re-hardening filter	SAT/ UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE FUEL OIL FILL, TRANSFER, AND PURIFICATION SYSTEM
CHECKED	
APPROVED	DRAWING NUMBER: 461-344- 8727 — REV: DRAFT
DATE	SCALE: NONE — SIZE: A — SHEET 1 OF 7

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the Fuel Oil Fill, Transfer, and Purification System. The operational test of the system will prove proper operation of the following equipment:

1.1 One (1) Fuel oil transfer pump

1.2 One (1) HFO duplex type strainer

1.3 One (1) Diesel oil transfer pump

1.4 One (1) DO duplex type strainer

1.5 Two (2) HFO purifier supply pumps (supplied with purifier package)

1.6 One (1) Diesel oil purifier supply pump (supplied with purifier package)

1.7 Three (3) partial discharge type purifiers

1.8 Two (2) Fuel oil heaters (supplied with purifier package)

1.9 One (1) In-line sterilizer (supplied with purifier package)

1.10 One (1) LSHFO settling tank

1.11 One (1) HFO settling tank

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.4, 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/1-42

2.4 Lloyd's Register, Classification of Ships, section 5/1.5.1.1

2.5 Japanese Industrial Standard Number 6602-79

2.6 Fuel Oil Fill, Transfer, and Purification System Diagram, Dwg. No. 7250-342-7114

2.7 Fuel oil purifier tech manual

3 TEST INSTRUCTION

3.1 Align Fuel Oil transfer system for normal operation, and operate each pump for 10 minutes to obtain system design conditions. Record all operating data, as listed, on data sheets provided. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.2 Demonstrate proper operation of relief valves, and automatic controls. Record all operating data, as listed, on data sheets provided.

3.3 Demonstrate the piping alignment for filling, transfer, and purification of heavy fuel oil and diesel oil to prove maximum operational flexibility between pumps and tanks utilizing manifolds. Record all operating data, as listed, on data sheets provided.

3.4 Demonstrate operation of FO Purifiers and associated supply pumps IAW Reference 2.7 by aligning system for normal operation and allowing purifiers to run for 10 minutes. System alignment may be for batch purification or transfer purification. Record all operating data, as listed, on data sheets provided.

Fuel Oil Transfer Pump Hull Number:______

OPERATIONAL TEST			
Item #	**Description**	**Design**	**Actual**
1	**MOTOR**		
	Volts:	460	
	Amps: Phase A	< 25	
	Amps: Phase B	< 25	
	Amps: Phase C	< 25	
	Rotation:	SAT/ UNSAT	
	RPM:	1760	
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Bearing Temp:	SAT/ UNSAT	
	Frame Temp:	SAT/ UNSAT	
2	**CONTROLLER**		
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
3	**PUMP**		
	Syst. Design Disch Press:	60 psi	
	Syst. Design Suct. Press:	0 - 10 psi	
	Relief Valve setting	75 psi (±3 psi)	
	Bearing Temp:	SAT/ UNSAT	
4	**OBSERVATIONS**		
	Noise:	SAT/ UNSAT	
	Vibration:	SAT/ UNSAT	
	Casing Temp:	SAT/ UNSAT	
	Leakage:	SAT/ UNSAT	
	Lubrication:	SAT/ UNSAT	
	Operation of duplex strainer	SAT/ UNSAT	

Diesel Oil Transfer Pump Hull Number:______

OPERATIONAL TEST			
Item #	**Description**	**Design**	**Actual**
5	**MOTOR**		
	Volts:	460	
	Amps: Phase A	< 8	
	Amps: Phase B	< 8	
	Amps: Phase C	< 8	
	Rotation:	SAT/ UNSAT	
	RPM:	1760	
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Bearing Temp:	SAT/ UNSAT	
	Frame Temp:	SAT/ UNSAT	
6	**CONTROLLER**		
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
7	**PUMP**		
	Syst. Design Disch Press:	40	
	Syst. Design Suct. Press:	0 - 10 psi	
	Relief Valve setting	55 psi (±3 psi)	
	Bearing Temp:	SAT/ UNSAT	
8	**OBSERVATIONS**		
	Noise:	SAT/ UNSAT	
	Vibration:	SAT/ UNSAT	
	Casing Temp:	SAT/ UNSAT	
	Leakage:	SAT/ UNSAT	
	Lubrication:	SAT/ UNSAT	
	Operation of duplex strainer	SAT/ UNSAT	

Heavy Fuel Oil Purifiers Hull Number:______

OPERATIONAL TEST				
Item #	**Description**	**Design**	**Actual**	
			#1	**#2**
9	**PURIFIER MOTOR**			
	Volts:	460		
	Amps:	< 26		
	Rotation:	SAT/ UNSAT		
	RPM:	1760		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
10	**CONTROLLER**			
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Manual local START/ STOP Switch	SAT/ UNSAT		
11	**SUPPLY PUMP**			
	Syst. Design Disch Press:	15 - 25 psi		
	Syst. Design Suct. Press:	0 - 5 psi		
	Bearing Temp:	SAT/ UNSAT		
	Relief valve setting	35 psi (±5 psi)		
12	**PURIFIER**			
	Discharge pressure	35 psi (±3 psi)		
	Proper discharge operation	SAT/ UNSAT		
	Bowl RPM	14,000		
	Alarms And Shutdowns	SAT/ UNSAT		
13	**HEATER**			
	Automatic temp. control systems	160°F (±5°F)		
	Proper operation of in-line sterilizer	SAT/ UNSAT		
	Heater relief valve	75 psi (±5 psi)		
14	**OBSERVATIONS**			
	Unusual Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Overheating:	SAT/ UNSAT		
	Leakage:	SAT/ UNSAT		
	Lubrication:	SAT/ UNSAT		

Diesel Oil Purifier Hull Number:______

OPERATIONAL TEST			
Item #	**Description**	**Design**	**Actual**
15	**PURIFIER MOTOR**		
	Volts:	460	
	Amps:	< 35	
	Rotation:	SAT/ UNSAT	
	RPM:	1760	
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Bearing Temp:	SAT/ UNSAT	
	Frame Temp:	SAT/ UNSAT	
16	**CONTROLLER**		
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Manual local START/ STOP Switch	SAT/ UNSAT	
17	**SUPPLY PUMP**		
	Syst. Design Disch Press:	15 - 25 psi	
	Syst. Design Suct. Press:	0 - 5 psi	
	Bearing Temp:	SAT/ UNSAT	
	Relief valve setting	75 psi (±5 psi)	
18	**PURIFIER**		
	Discharge pressure	35 psi (±3 psi)	
	Proper discharge operation	SAT/ UNSAT	
	Bowl RPM	14,000	
	Alarms And Shutdowns	SAT/ UNSAT	
19	**HEATER**		
	Automatic temp. control systems	160°F (±5°F)	
	Heater relief valve	75 psi (±5 psi)	
20	**OBSERVATIONS**		
	Unusual Noise:	SAT/ UNSAT	
	Vibration:	SAT/ UNSAT	
	Overheating:	SAT/ UNSAT	
	Leakage:	SAT/ UNSAT	
	Lubrication:	SAT/ UNSAT	

FO Fill, Transfer, and Purification System Hull Number:______

OPERATIONAL TEST			
Line Item #	**Description**	**Design**	**Actual**
21	Ability to gravity fill from, and discharge to:		
	Port fill connection	SAT/ UNSAT	
	Stbd. fill connection	SAT/ UNSAT	
22	Ability to fill and take suction from:		
	HFO Storage tank #1	SAT/ UNSAT	
	HFO Storage tank #2	SAT/ UNSAT	
	HFO Storage tank #3	SAT/ UNSAT	
	HFO Storage tank #4	SAT/ UNSAT	
23	Ability to fill and take suction from:		
	HFO Service Tank #1	SAT/ UNSAT	
	HFO Service Tank #2	SAT/ UNSAT	
24	Ability to fill and take suction from:		
	LSHFO Service Tank #1	SAT/ UNSAT	
	LSHFO Service Tank #2	SAT/ UNSAT	
25	Ability to fill and take suction from:		
	LSHFO Settling Tank	SAT/ UNSAT	
	HFO Settling Tank	SAT/ UNSAT	
26	Ability to fill and take suction from LSHFO Storage Tank	SAT/ UNSAT	
27	Ability to fill and take suction from:		
	MDO Storage Tank	SAT/ UNSAT	
	MDO Service Tank	SAT/ UNSAT	
28	Ability of FO Transfer Pump to take suction from, and pump to associated manifolds	SAT/ UNSAT	
29	Ability of DO Transfer Pump to take suction from, and pump to associated manifolds	SAT/ UNSAT	
30	Ability of HFO Purifier #1 to take suction from, and discharge to associated manifolds	SAT/ UNSAT	
31	Ability of HFO Purifier #2 to take suction from, and discharge to associated manifolds	SAT/ UNSAT	
32	Ability of DO Purifier to take suction from, and discharge to associated manifolds	SAT/ UNSAT	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE PROVISION CRANES AND LIFTING DAVITS	
CHECKED		
APPROVED	DRAWING NUMBER	REV
	461-344- 8737	DRAFT
DATE	SCALE: NONE SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the provision cranes and lifting davits. The operational test will prove proper operation of the following equipment:

1.1 Two (2) 5 metric ton, electro-hydraulic provision cranes

1.2 Four (4) portable lifting davits

1.3 One (1) fixed davit with air powered motor driven winch

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, sections H-38 & H-28.7

2.2 American Bureau of Shipping, Guide for Certification of Cranes 1987, Section 5

2.3 American Bureau of Shipping, Certification of Construction and Survey of Cargo Gear on Merchant Vessels 1975, Section 3.3

2.4 Det Norske Veritas - Rules for Classification, 6/1-7

2.5 SNAME Technical and Research Bulletin 3-39 - Guide for Shop and Installation Tests, paragraph 4.27.2

2.6 General Arrangement - Dwg. No. 7250-341-7008 Rev. -

2.7 Tech Manual - Provision cranes

3 TEST INSTRUCTION

3.1 **Proof Load Test -** The proof load testing of the provision cranes will be carried out using known moveable weights. The proof is equal to the SWL plus 25%, for these cranes the proof load is 6.25 metric tons. Demonstrate the cranes ability to handle the proof load through all conditions representing intended service. Verify hoisting, luffing, slewing, and lowering throughout the entire range of travel. Observe for any signs of permanent damage or deformation. Record all operating data, as listed, on data sheets provided.

3.2 **Brakes and Fail-safe Devices -** Demonstrate the operation of the provision crane brake under simulated loss of power conditions. Prove proper operation of the emergency manual stop. Verify the proper operation of safeties and fail-safe devices IAW reference 2.6. Record all data, as listed, on data sheets provided.

3.3 Demonstrate proper fitup of provision crane boom and hook in the stowage arrangement Record results on data sheets provided.

3.4 Verify proper fitup of the portable davits in each socket, demonstrate that davits can be rotated without using excessive force. Verify proper fitup of davit boom in each storage.

3.5 **Davit Operational Test -** The proof load testing of the davits will be carried out using known moveable weights. The proof is equal to the SWL plus 25%, for these davits the proof load is 1.25 metric tons. Demonstrate each davits ability to handle the proof load through all conditions representing intended service. Observe for any signs of permanent damage or deformation.

3.6 Demonstrate operation of air powered winch for fixed davit.

PROVISION CRANES

PROOF LOAD & OPERATIONAL TEST			Hull Number:______
ITEM NUMBER		**1**	**2**
Description	**Design**	**Actual**	
PROVISION CRANE		Port	Starboard
MOTOR			
Volts:	460 (±23 Volts)		
Amps: Phase A	< 125		
Amps: Phase B	< 125		
Amps: Phase C	< 125		
Rotation:	SAT/ UNSAT		
RPM:	1780 (±70 RPM)		
Cold Insulation Resistance:	>1MΩ		
Hot Insulation Resistance:	>1MΩ		
Bearing Temp:	SAT/ UNSAT		
Frame Temp:	SAT/ UNSAT		
OBSERVATIONS			
Noise:	SAT/ UNSAT		
Vibration:	SAT/ UNSAT		
Casing Temp:	SAT/ UNSAT		
Lubrication: (gearbox level)	SAT/ UNSAT		
PUMP PRESSURE READINGS			
Slewing			
Luffing			
Hoisting			
ITEM NUMBER		**3**	**4**
BRAKES AND FAIL-SAFE DEVICES			
Brake holds load upon loss of power	SAT/ UNSAT		
Operation of emergency manual stop	SAT/ UNSAT		
Hook overtravel safety	SAT/ UNSAT		
Hydrualic oil low level float switch	SAT/ UNSAT		
Hydrualic oil over-temperature switch	80°C ±2°C		
Hydrualic pump relief valve setting	276 bar ±2.8 bar		
ITEM NUMBER		**5**	**6**
Proper fitup in stowage arrangement	SAT/ UNSAT		

PORTABLE AND FIXED DAVITS

PROOF LOAD & OPERATIONAL TEST					Hull Number:______
ITEM NUMBER	**7**	**8**	**9**	**10**	**11**
DAVIT	**1**	**2**	**3**	**4**	**5 (Fixed)**
Proper fitup in socket					
Proper fitup in storage					
Rotates without excessive force					
Operational test with proof load					
No permanent deformation					
Operation of air powered winch					

Note: Expected results: SAT/UNSAT.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM

1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE INCINERATOR AND SLUDGE TRANSFER SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8738		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the incinerator and sludge transfer system. The operational test of the system will prove proper operation of the following equipment:

1.1 One (1) incinerator with attached pump and fan

1.2 One (1) diesel oil day tank

1.3 One (1) sludge day tank with pump

1.4 Two (2) sludge transfer pumps And associated suction strainers

1.5 Two (2) waste oil tanks

1.6 Two (2) oil sludge tanks

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section M-7.0

2.2 American Society for Testing and Materials, F 1323.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 4/3-47

2.4 Japanese Industrial Standard 7011-89

2.5 International Maritime Organization, Resolution MEPC 59(33), paragraph 7.3

2.6 International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), Annex V.

2.7 Sludge Transfer / Incinerator Fuel Service Diagram, Dwg. No. 7250-342-7119 Rev. -

2.8 Tech Manual - Golar Marine Incinerator Type GS 500 w/ stirrer

3 TEST INSTRUCTION

3.1 Align the incinerator to prove the unit's ability to burn sludge, solids, and sludge and solids. Prove combustion controls are stable and operate smoothly. Demonstrate programming controls and fuel supply controls. Record all operating data, as listed, on data sheets provided.

3.2 Align the sludge transfer pumps and demonstrate the pumps' ability to take suction from, and discharge to associated tanks as indicated on data sheets. Record data, as appropriate, on data sheets provided.

INCINERATOR OPERATIONAL TEST			Hull Number:______
Item #	**Description**	**Design**	**Actual**
	INCINERATOR		
1	Ability to burn sludge at rated capacity	1-1.5% total fuel consumption / 15 hrs	_________ L/hr
2	Ability to burn solids at rated capacity	Rated = 46.5 kg/hr	_________ kg/hr
3	Ability to burn solids and sludge simultaneously at rated capacity	SAT/ UNSAT	
4	Combustion Controls	SAT/ UNSAT	
5	Programming Controls	SAT/ UNSAT	
6	Fuel Supply Controls	SAT/ UNSAT	
7	Alarms	SAT/ UNSAT	
	SAFETY SHUTDOWNS		
8	Flame safeguard (flame and ignition failure)	SHUTDOWN	
9	Limit controls	SHUTDOWN	
10	Fuel oil pressure/temperature limit control	SHUTDOWN	
11	Low voltage test	SHUTDOWN	
12	High exhaust temperature	SHUTDOWN	
	PROPER OPERATION		
13	Diesel Oil Pump/ Motor	SAT/ UNSAT	
14	Sludge Tank Pump/Motor	SAT/ UNSAT	
15	Combustion Air Blower Motor	SAT/ UNSAT	
16	Flue Gas Fan Motor	SAT/ UNSAT	
17	Air Fan For Stirrer Motor	SAT/ UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

SLUDGE TRANSFER SYSTEM - OPERATIONAL TEST			Hull Number:______
Item #	**Description**	**Design**	**Actual**
18	Ability of #1 sludge transfer pump to take suction from:		
	Oil sludge tank	SAT/ UNSAT	
	Waste oil tank	SAT/ UNSAT	
	FO Fill and Transfer System	SAT/ UNSAT	
19	Ability of #1 sludge transfer pump to discharge to:		
	Dirty slop tank (via cargo system)	SAT/ UNSAT	
	Waste oil tank	SAT/ UNSAT	
	Sludge day tank	SAT/ UNSAT	
20	Ability of #2 sludge transfer pump to take suction from:		
	Oil sludge tank	SAT/ UNSAT	
	Waste oil tank	SAT/ UNSAT	
	FO Fill and Transfer System	SAT/ UNSAT	
21	Ability of #2 sludge transfer pump to discharge to:		
	Dirty slop tank (via cargo system)	SAT/ UNSAT	
	Waste oil tank	SAT/ UNSAT	
	Sludge day tank	SAT/ UNSAT	

WITNESSED BY	DATE
SHIPBUILDER:	
CUSTOMER:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE CARGO OIL SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8740		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 6

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the Cargo Oil System. The operational test of the system will prove proper operation of the following equipment:

1.1 Two (2) Cargo oil pumps (variable speed)

1.2 One (1) Cargo oil/crude oil wash pump

1.3 One (1) Cargo oil stripping pump (variable speed)

1.4 One (1) Cargo oil stripping eductor

1.5 One (1) Oil content monitor (cargo oil)

1.6 One (1) Cargo oil pump vacuum priming system

1.7 One (1) Catch basin drain pump (portable air diaphragm)

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.7.6, 4/6.7.8

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 5/3-13, 4/1-42

2.4 Lloyd’s Register, Classification of Ships, Part 5/12.7.1, 5/1.5.1.1

2.5 Cargo Oil System Diagram, Dwg. No. 7250-342-7104

2.6 Oil content monitor system tech manual

3 TEST INSTRUCTION

3.1 Align system for normal operation, and demonstrate the systems ability to discharge at the design capacity using sea water in lieu of cargo oil. Each pump shall be operated for a minimum of one hour (at stable conditions) to determine cargo discharge capacity. A discharge pressure of 150 psi shall be maintained at the rail. Pumps shall be aligned to to take suction from a tank with a sufficient level to support the duration of the testing event. Verification of water discharge capacity can be confirmed by tank level indicators, or by sounding tape. Record all operating data, as listed, on data sheets provided.

NOTE: This test is designed to verify the capacity of each pump, system off-loading capability will be demonstrated during Sea Trials - Test Procedure 8930. Tank hatches to remain open during capacity testing, and inert gas system shall not be in use.

3.2 During operation of system, record all pump operating data, as listed, on data sheets provided. Prove proper operation of the vacuum priming system. Design data not shown on the data sheets shall be obtained from subject equipment nameplate data, and entered on the data sheets.

3.3 Demonstrate proper operation of the automatic stripping/unloading system, including operation of the associated stripping pumps.

3.4 Demonstrate proper operation of cargo oil content monitor system IAW reference 2.6. Record all operating data, as listed, on data sheets provided.

3.5 Align the cargo oil stripping eductor to demonstrate the eductors’ ability to take suction from the farthest tanks (#1 CO Tanks). Verify the capacity of the eductor system. Record results, as listed, on data sheets provided.

3.6 Demonstrate proper operation of the cargo oil catch basin drain pump. Record all operating data, as listed, on data sheets provided.

Cargo Oil and CO/COW Pumps Hull Number:______

OPERATIONAL TEST					
Item #	**Description**	**Design**	**Actual**		
			Cargo Oil Pump #1	Cargo Oil Pump #2	CO/COW Pump
1	**MOTOR**				
	Volts:	6600			
	Amps: Phase A	<150			
	Amps: Phase B	<150			
	Amps: Phase C	<150			
	Rotation:	SAT/ UNSAT			
	RPM:	1800			
	Cold Insulation Resistance:	>1MΩ			
	Hot Insulation Resistance:	>1MΩ			
	Bearing Temp:	SAT/ UNSAT			
	Frame Temp:	SAT/ UNSAT			
2	**CONTROLLER**				
	Cold Insulation Resistance:	>1MΩ			
	Hot Insulation Resistance:	>1MΩ			
3	**PUMP**				
	Syst. Design Disch Press:	150 psi			
	Syst. Design Suct. Press:	0 15 psi			
	Relief Valve setting	165 psi (±5 psi)			
	Bearing Temp:	SAT/ UNSAT			
4	**OBSERVATIONS**				
	Noise:	SAT/ UNSAT			
	Vibration:	SAT/ UNSAT			
	Casing Temp:	SAT/ UNSAT			
	Leakage:	SAT/ UNSAT			
	Lubrication:	SAT/ UNSAT			
5	**CARGO OIL PUMP VACUUM PRIMING UNIT.**				
	Operation of air separators	SAT/ UNSAT			
	Ooperation of vacuum priming pumps	15 - 28” Hg			

Cargo Oil Pump Discharge Capacity Test Hull Number:______

Item #	Description	Units	Actual			
			Start	20 min.	40 min.	60 min.
6	**PUMP #1**					
	Discharge pressure	psig				
	Tank Sounding (if used)	ft and inches				
	Tank Volume (sounding or TLI)	gallons				
	Difference of Volume	gallons				
	Total pumped	gallons				
	Pump capacity Design = 14,664 gpm (4000 m^3/hr)	gal./min.				
7	**PUMP #2**					
	Discharge pressure	psig				
	Tank Sounding (if used)	ft and inches				
	Tank Volume (sounding or TLI)	gallons				
	Difference of Volume	gallons				
	Total pumped	gallons				
	Pump capacity Design = 14,664 gpm (4000 m^3/hr)	gal./min.				
8	**CARGO/COW PUMP**					
	Discharge pressure	psig				
	Tank Sounding (if used)	ft and inches				
	Tank Volume (sounding or TLI)	gallons				
	Difference of Volume	gallons				
	Total pumped	gallons				
	Pump capacity Design = 10,126 gpm (2300 m^3/hr)	gal./min.				
9	Proper operation of oil content monitor	SAT/ UNSAT				
10	Proper operation of catch basin drain pump	SAT/ UNSAT				

Cargo Oil Stripping Pump Hull Number:______

Item #	Description	Design	Actual
	OPERATIONAL TEST		
11	**MOTOR**		
	Volts:	460	
	Amps: Phase A	<50	
	Amps: Phase B	<50	
	Amps: Phase C	<50	
	Rotation:	SAT/ UNSAT	
	RPM:	1200	
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Bearing Temp:	SAT/ UNSAT	
	Frame Temp:	SAT/ UNSAT	
12	**CONTROLLER**		
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
13	**PUMP**		
	Syst. Design Disch Press:	150 psi	
	Syst. Design Suct. Press:	0 - 15 psi	
	Relief Valve setting	165 psi (±5 psi)	
	Bearing Temp:	SAT/ UNSAT	
14	**OBSERVATIONS**		
	Noise:	SAT/ UNSAT	
	Vibration:	SAT/ UNSAT	
	Casing Temp:	SAT/ UNSAT	
	Leakage:	SAT/ UNSAT	
	Lubrication:	SAT/ UNSAT	
15	Proper operation of automatic stripping/unloading system.	SAT/ UNSAT	
16	**CARGO OIL STRIPPING EDUCTOR**		
	Eductor actuation pressure	184 psi (±5 psi)	
	Eductor discharge pressure	184 psi (±5 psi)	
	Discharge capacity	2,971 gpm (675 m^3/hr)	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM

1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE FIXED TANK CLEANING SYSTEM		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8741		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 3

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the Fixed Tank Cleaning System. The operational test of the system will prove proper operation of the following equipment:

1.1 One (1) Tank cleaning heater and drain cooler

1.2 One (1) Cargo oil/crude oil wash pump

1.3 Eighteen (18) Fixed tank cleaning machines

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels, Section 4/6.71.2, 4/6.7.6, 4/6.7.8

2.3 Fixed Tank Cleaning System Diagram, Dwg. No. 7250-342-7125

2.4 Cargo Oil System Diagram, Dwg. No. 7250-342-7104

2.5 Tank cleaning heater tech manual

2.6 Fixed tank cleaning machine tech manual

3 TEST INSTRUCTION

3.1 Align system for normal operation IAW reference 2.5, and demonstrate the ability of the tank cleaning heater to achieve design capacity using sea water. The system shall be operated for a sufficient time to confirm tank cleaning heater capacity. A discharge pressure of approximately 120 psi shall be maintained at the most remote machine. Record all operating data, as listed, on data sheets provided.

NOTE: This test is designed to verify the capacity of the tank cleaning heater. Each pump, and the system off-loading capability will be demonstrated during the Cargo Oil System Test Procedure - 8740, and the Sea Trials Test Procedure - 8930. Tank hatches to remain open during tank cleaning heater capacity testing.

3.2 Demonstrate proper operation of each fixed tank cleaning machine IAW reference 2.6. Record all operating data, as listed, on data sheets provided.

Tank Cleaning Heater Capacity Test Hull Number:______

Item #	Description	Design	Actual			
			Start	20 min.	40 min.	60 min.
1	**Tank Cleaning Heater**					
	Seawater discharge pressure	200 psig				
	Steam pressure	100 psig				
	Seawater inlet temperature	62°F (17°C)				
	Seawater outlet temperature	180°F (82°C)				

Tank Cleaning Machines

Item #	Description	Discharge press.	Jet nozzle rotation	Power unit function
	Design	120 psi (± 12 psi)	(SAT/UNSAT)	(SAT/UNSAT)
2	**Tank Cleaning Machines**			
	No. 1 CO Tank Port			
	No. 1 CO Tank Ctr			
	No. 1 CO Tank Stbd			
	No. 2 CO Tank Port			
	No. 2 CO Tank Ctr			
	No. 2 CO Tank Stbd			
	No. 3 CO Tank Port			
	No. 3 CO Tank Ctr			
	No. 3 CO Tank Stbd			
	No. 4 CO Tank Port			
	No. 4 CO Tank Ctr			
	No. 4 CO Tank Stbd			
	No. 5 CO Tank Port			
	No. 5 CO Tank Ctr			
	No. 5 CO Tank Stbd			
	No. 6 CO Tank Port			
	No. 6 CO Tank Ctr			
	No. 6 CO Tank Stbd			

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE ENGINE ROOM BRIDGE CRANE		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8744		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 3

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
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1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the engine room bridge cranes. The operational test will prove proper operation of the following equipment:

1.1 Two (2) 7.5 metric ton, electric bridge type cranes

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, sections M 6.5.1

2.2 American Bureau of Shipping, Guide for Certification of Cranes 1987, Section 5

2.3 American Bureau of Shipping, Certification of Construction and Survey of Cargo Gear on Merchant Vessels 1975, Section 3.3

2.4 Det Norske Veritas - Rules for Classification, 6/1-7

2.5 SNAME Technical and Research Bulletin 3-39 - Guide for Shop and Installation Tests, paragraph 4.27.2

2.6 Machinery Arrangement - Dwg. No. 7250-342-7147 Rev. -

2.7 Machinery and Lifting Gear Arrangement - Dwg. No. 7250-351-4950 Rev. -

2.8 Tech Manual - Engine room bridge cranes

3 TEST INSTRUCTION

3.1 **Operational Load Test** - The operational load testing of the engine room bridge cranes will be carried out using known moveable weights. The operational test weight is equal to 7 metric tons (15,432 lbs). Demonstrate the cranes ability to handle the test load through all conditions representing intended service. Verify hoisting, travel, and traversing throughout the entire range of travel. Observe for any signs of permanent damage or deformation. Record all operating data, as listed, on data sheets provided. Note: Motor data to be taken only as practical and safe.

3.2 **Brakes and Fail-safe Devices** - Demonstrate the operation of the engine room bridge crane brake. Verify the proper operation of safeties, limit switches, and fail-safe devices IAW reference 2.8. Record all data, as listed, on data sheets provided.

ENGINE ROOM BRIDGE CRANES

OPERATIONAL LOAD TEST			Hull Number:______
ITEM NUMBER		**1**	**2**
Description	**Design**	**Actual**	
ENGINE ROOM BRIDGE CRANE		Port	Starboard
MOTOR			
Volts:	460 (±23 Volts)		
Amps: Phase A	< 12		
Amps: Phase B	< 12		
Amps: Phase C	< 12		
Rotation:	SAT/ UNSAT		
RPM:	1780 (±70 RPM)		
Cold Insulation Resistance:	>1MΩ		
Hot Insulation Resistance:	>1MΩ		
Bearing Temp:	SAT/ UNSAT		
Frame Temp:	SAT/ UNSAT		
OBSERVATIONS			
Noise:	SAT/ UNSAT		
Vibration:	SAT/ UNSAT		
Casing Temp:	SAT/ UNSAT		
Lubrication: (gearbox level)	SAT/ UNSAT		
OPERATIONAL LOAD TEST			
Crane handles load smoothly and safely	SAT/ UNSAT		
Crane travels and traverses to all intended areas	SAT/ UNSAT		
Hook has sufficient cable to reach lowest deck serviced.	SAT/ UNSAT		
No permanent damage or deformation of crane rails	SAT/ UNSAT		
BRAKES AND FAIL-SAFE DEVICES			
Brake holds load upon loss of power	SAT/ UNSAT		
Hoist limit switches	SAT/ UNSAT		
Trolley travel limit switches	SAT/ UNSAT		
Long travel limit switches	SAT/ UNSAT		

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE MOORING WINCHES		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8805		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 6

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
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1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the mooring winches. The operational test of the system will prove proper operation of the following equipment:

1.1 Three (3) mooring winches fitted with two (2) mooring drums and one (1) warping head, and associated electro-hydraulic power pack (1), with attached pumps (2), mounted below decks aft.

1.2 Two (2) single winches with single drums and one (1) warping head. Associated (dedicated) electro-hydraulic power packs (2), with attached pumps (2), mounted below decks forward.

1.3 Four (4) spring line winches each with one (1) mooring drum and a warping head. Associated (integral) electro-hydraulic power packs (4), with attached pumps (4), mounted in the cargo block area.

1.4 Note: Operation of the two (2) mooring winch / anchor windlass combination units will be demonstrated by Test Procedure 8826 - Anchor Windlass.

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section M-28.2

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels Part 1/2.3, 4/1.11.1

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 3/3-36

2.4 Lloyd’s Register, Classification of Ships, Part 3/13.7

2.5 Japanese Industrial Standard 6714-95

2.6 OCIMF Mooring Equipment Guidelines for the Mooring of Large Vessels.

2.7 Mooring Arrangement Fwd. - Dwg. No. 7250-331-4764 Rev. -

2.8 Mooring Arrangement Midship. - Dwg. No. 7250-331-4765 Rev. -

2.9 Mooring Arrangement Aft. - Dwg. No. 7250-331-4766 Rev. -

2.10 Tech Manual - Mooring winch unit - with mooring drums, and warping head.

3 TEST INSTRUCTION

3.1 **No Load Test -** Ensure the hydraulic system is filled and vented, and align the system for normal operation. The no load test is to be performed prior to loading the mooring wires. Perform the no load test by operating the winch once in the normal direction and once in the reverse direction for a sum of 30 minutes at rated speed. During the no load test all remote and local controls shall be demonstrated. During the no load operational test, where applicable, all combinations of pumps and winches will be demonstrated. Record all operating data, as listed, on data sheets provided.

3.2 **Operational (Load) Test -** The load testing of the mooring winches will be carried out as part of the Sea Trial Test Procedure - 8930.

3.3 **Brake Test -** The normal functioning of the brake shall be demonstrated on the winch running under no load. Record all operating data, as listed, on data sheets provided. The holding load inspection is accomplished as part of the Type Inspection completed by the manufacturer at his facility.

FORWARD SINGLE-DRUM MOORING WINCH

NO LOAD OPERATIONAL TEST			Hull Number:______
ITEM NUMBER		**1**	**2**
Description	**Design**	**Actual**	
MOTOR		WINCH #1	WINCH #2
Volts:	460 (±23 Volts)		
Amps: Phase A	< 130		
Amps: Phase B	< 130		
Amps: Phase C	< 130		
Rotation:	SAT/ UNSAT		
RPM:	1780 (±70 RPM)		
Cold Insulation Resistance:	>1MΩ		
Hot Insulation Resistance:	>1MΩ		
Bearing Temp:	SAT/ UNSAT		
Frame Temp:	SAT/ UNSAT		
HYDRAULIC PUMP OBSERVATIONS			
Noise:	SAT/ UNSAT		
Vibration:	SAT/ UNSAT		
Casing Temp:	SAT/ UNSAT		
Hydraulic System Leakage:	None		
Lubrication:	SAT/ UNSAT		
System relief valve setting	650 psi +0/-65		
WINDLASS OPERATION			
Brake functioning	SAT/ UNSAT		
Clutch functioning	SAT/ UNSAT		
Local control function	SAT/ UNSAT		
Remote control function	SAT/ UNSAT		
Oil level switch on hydraulic tank, alarm/shutdown	SAT/ UNSAT		
High oil temperature alarm/shutdown	175° F (80°C)		
WITNESSED BY:	SHIPBUILDER		
	CUSTOMER		

DOUBLE-DRUM SPRING LINE MOORING WINCHES

NO LOAD OPERATIONAL TEST					Hull Number:______
ITEM NUMBER		**3**	**4**	**5**	**6**
Description	**Design**	**Actual**			
MOTOR		WINCH #3	WINCH #4	WINCH #5	WINCH #6
Volts:	460 (±23 Volts)				
Amps: Phase A	< 130				
Amps: Phase B	< 130				
Amps: Phase C	< 130				
Rotation:	SAT/ UNSAT				
RPM:	1780 (±70 RPM)				
Cold Insulation Resistance:	>1MΩ				
Hot Insulation Resistance:	>1MΩ				
Bearing Temp:	SAT/ UNSAT				
Frame Temp:	SAT/ UNSAT				
HYDRAULIC PUMP OBSERVATIONS					
Noise:	SAT/ UNSAT				
Vibration:	SAT/ UNSAT				
Casing Temp:	SAT/ UNSAT				
Hydraulic System Leakage:	None				
Lubrication:	SAT/ UNSAT				
System relief valve setting	650 psi +0/-65				
WINDLASS OPERATION					
Brake functioning	SAT/ UNSAT				
Clutch functioning	SAT/ UNSAT				
Local control function	SAT/ UNSAT				
Remote control function	SAT/ UNSAT				
Oil level switch on hydraulic tank, alarm/shutdown	SAT/ UNSAT				
High oil temperature alarm/shutdown	175° F (80°C)				
WITNESSED BY:	SHIPBUILDER				
	CUSTOMER				

AFT DOUBLE-DRUM MOORING WINCHES

NO LOAD OPERATIONAL TEST Hull Number:______

ITEM NUMBER		**7**	**8**
Description	**Design**	**Actual**	
MOTOR		PUMP #7	PUMP #8
Volts:	460 (±23 Volts)		
Amps: Phase A	< 130		
Amps: Phase B	< 130		
Amps: Phase C	< 130		
Rotation:	SAT/ UNSAT		
RPM:	1780 (±70 RPM)		
Cold Insulation Resistance:	>1MΩ		
Hot Insulation Resistance:	>1MΩ		
Bearing Temp:	SAT/ UNSAT		
Frame Temp:	SAT/ UNSAT		
HYDRAULIC PUMP OBSERVATIONS			
Noise:	SAT/ UNSAT		
Vibration:	SAT/ UNSAT		
Casing Temp:	SAT/ UNSAT		
Hydraulic System Leakage:	None		
Lubrication:	SAT/ UNSAT		
System relief valve setting	650 psi +0/-65		
WITNESSED BY:	SHIPBUILDER		
	CUSTOMER		

ITEM NUMBER		**9**	**10**	**11**
WINCH OPERATION		WINCH #7	WINCH #8	WINCH #9
Brake functioning	SAT/ UNSAT			
Clutch functioning	SAT/ UNSAT			
Local control function	SAT/ UNSAT			
Remote control function	SAT/ UNSAT			
Oil level switch on hydraulic tank, alarm/shutdown	SAT/ UNSAT			
High oil temperature alarm/shutdown	175° F (80°C)			
WITNESSED BY:	SHIPBUILDER			
	CUSTOMER			

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE LIFEBOATS AND LIFEBOAT DAVITS		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8806		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 5

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the two 40 foot lifeboats, associated pivot gravity type davits, and lifeboat battery chargers. The operational test will prove proper operation of the following equipment:

1.1 Two (2) fiberglass, enclosed, self-righting lifeboats

1.2 Two (2) pivot gravity type davits and associated winches

1.3 Two (2) lifeboat battery chargers

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, sections H-35

2.2 IMO Resolution A.689(17) pp.145

2.3 46 CFR 199.45

2.4 Det Norske Veritas - Rules for Classification, 3/6-2

2.5 SNAME Technical and Research Bulletin 3-39 - Guide for Shop and Installation Tests, paragraph 4.28.2.1

2.6 SOLAS Chapter 3, Regulations 39 and 48

2.7 Lifeboats / Rescue Boats Arrangement and Details - Dwg. No. 7250-332-4722 Rev. -

2.8 Tech Manual - Lifeboat

2.9 Tech Manual - Pivot gravity type davit

3 TEST INSTRUCTION

3.1 **Static Proof Load Test -** Suspend a weight of 56,320 lbs (representing 2.2 times the working load) from the davit arms. Do not use the winch to lift this weight. Observe for any signs of permanent damage or deformation. Record all data, as listed, on data sheets provided.

3.2 **Static Brake Test -** Suspend a weight of 38,400 lbs (representing 1.5 times the working load) from the falls. Do not use the winch to lift this weight. Verify that the brake holds the load for 5 minutes. Observe for any signs of permanent damage or deformation. Record all data, as listed, on data sheets provided.

3.3 **Dynamic Load Test -** The dynamic load test will be accomplished using the boat and known moveable weights. The dynamic proof load is equal to the maximum working load plus 10%, for these davits 11,240 lbs of weight shall be added to the boat. Lower the loaded boat from the on-deck control station until maximum lowering speed is reached. Apply the brake and verify that the brake stops and holds the load by the action of the counterweight alone. **Do not attempt to hoist this weight.** Lower boat to water, prove operation of releasing gear, remove 2560 lbs from the boat, and hoist the boat to the stowage using the winch. Record one set of motor data reading during hoisting. Observe for any signs of permanent damage or deformation. Record all operating data, as listed, on data sheets provided.

3.4 **Fail-safe Devices -** Prove proper operation of the emergency disconnect switch, limit switches, and verify the proper operation of safeties and fail-safe devices IAW reference 2.6. Record all data, as listed, on data sheets provided.

3.5 **Launch and Recovery Test -** Demonstrate the ability to lower and launch the boat from inside the boat using the remote control wire. Prove operation of the brake control via the remote control wire. Verify minimum lowering speed. Recover and hoist the boat into the stowage. Demonstrate proper fitup of lifeboats in the stowage arrangement. Record results on data sheets provided.

3.6 **Lifeboat Operation Test -** Prove proper operation of each lifeboat IAW reference 2.8. Record results on data sheets provided.

3.7 **Battery Charger Test -** Demonstrate proper operation of the lifeboat battery chargers. Record results on data sheets provided.

RESCUE BOAT AND DAVIT

PROOF LOAD & OPERATIONAL TEST			Hull Number:______	
Item #	**Description**	**Design**	**Actual**	
			Port	Stbd
1	STATIC PROOF LOAD TEST (Davit holds 56,320 lbs)	No deformation (SAT/UNSAT)		
2	STATIC BRAKE TEST (Brake holds 38,400 lbs)	No deformation / slippage (SAT/UNSAT)		
3	DYNAMIC LOAD TEST: (11,240 lbs in boat)			
	Boat lowers properly	1.0 m/sec ≤ SPEED ≤ 1.3 m/sec.		
	Brake stops boat, and holds weight	(SAT/UNSAT)		
	Winch hoists boat and weight (8680lbs) properly	SPEED ≥ .3 m/sec (1 ft/sec)		
	MOTOR			
	Volts:	460 (±23 Volts)		
	Amps: Phase A	< 27		
	Amps: Phase B	< 27		
	Amps: Phase C	< 27		
	Rotation:	SAT/ UNSAT		
	RPM:	1780 (±70 RPM)		
	Cold Insulation Resistance:	>1MΩ		
	Hot Insulation Resistance:	>1MΩ		
	Bearing Temp:	SAT/ UNSAT		
	Frame Temp:	SAT/ UNSAT		
	OBSERVATIONS			
	Noise:	SAT/ UNSAT		
	Vibration:	SAT/ UNSAT		
	Casing Temp:	SAT/ UNSAT		
	Lubrication: (gearbox level)	SAT/ UNSAT		
4	FAIL-SAFE DEVICES			
	Hoist limit switch	SAT/ UNSAT		
	Operation of emergency disconnect	SAT/ UNSAT		
5	LAUNCH AND RECOVERY TEST			
	Boat lowers via remote control wire	SAT/ UNSAT		
	Brake operation via remote control wire	SAT/ UNSAT		
	Boat minimum lowering speed	≥ 70% of actual speed of dynamic load test		
	Boat successfully launched	SAT/ UNSAT		

PROOF LOAD & OPERATIONAL TEST			Hull Number:______	
Item #	**Description**	**Design**	**Actual**	
	Boat recovery and hoist	SAT/ UNSAT		
	Operation of hand crank to raise boat	SAT/ UNSAT		
	Proper fitup in stowage arrangement	SAT/ UNSAT		
6	LIFEBOAT OPERATION			
	Throttle control	SAT/ UNSAT		
	Transmission	SAT/ UNSAT		
	Steering	SAT/ UNSAT		
7	Battery Charger Operation	SAT/ UNSAT		

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE RESCUE BOAT HANDLING / OPS		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8807		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 5

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
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Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the 20 foot rigid-hull inflatable rescue boat and associated Miranda gravity davit. The operational test will prove proper operation of the following equipment:

1.1 One (1) 20 foot rigid-hull inflatable rescue boat

1.2 One (1) dedicated Miranda gravity davit and associated winch

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, sections H-35

2.2 IMO Resolution A.689(17) pp.145

2.3 46 CFR 199.45

2.4 Det Norske Veritas - Rules for Classification, 3/6-2

2.5 SNAME Technical and Research Bulletin 3-39 - Guide for Shop and Installation Tests, paragraph 4.28.2.1

2.6 SOLAS Chapter 3, Regulations 39 and 48

2.7 Lifeboats / Rescue Boats Arrangement and Details - Dwg. No. 7250-332-4722 Rev. -

2.8 Tech Manual - Rescue boat

2.9 Tech Manual - Type MRT 2500 Miranda gravity davit

3 TEST INSTRUCTION

3.1 **Static Proof Load Test -** Suspend a weight of 4050 lbs (representing 2.2 times the working load) from the davit arms. Do not use the winch to lift this weight. Observe for any signs of permanent damage or deformation. Record all data, as listed, on data sheets provided.

3.2 **Static Brake Test -** Suspend a weight of 2760 lbs (representing 1.5 times the working load) from the falls. Do not use the winch to lift this weight. Verify that the brake holds the load for 5 minutes. Observe for any signs of permanent damage or deformation. Record all data, as listed, on data sheets provided.

3.3 **Dynamic Load Test -** The dynamic load test will be accomplished using the boat and known moveable weights. The dynamic proof load is equal to the maximum working load plus 10%, for these davits 1650 lbs of weight shall be added to the boat. Lower the loaded boat from the on-deck control station until maximum lowering speed is reached. Apply the brake and verify that the brake stops and holds the load by the action of the counterweight alone. Lower boat to water, remove 375 lbs from the boat, and hoist the boat to the stowage using the winch. Record one set of motor data reading during hoisting. Observe for any signs of permanent damage or deformation. Record all operating data, as listed, on data sheets provided.

3.4 **Fail-safe Devices -** Prove proper operation of the emergency disconnect switch, limit switiches, and verify the proper operation of safeties and fail-safe devices IAW reference 2.6. Record all data, as listed, on data sheets provided.

3.5 **Launch and Recovery Test -** Demonstrate the ability to lower and launch the boat from inside the boat using the remote control wire. Prove operation of the brake control via the remote control wire. Recover and hoist the boat into the stowage. Demonstrate proper fitup of rescue boat and cradle in the stowage arrangement Record results on data sheets provided.

3.6 **Operational Test of Rescue Boat -** Demonstrate proper operation of the rescue boat. Prove functioning of the throttle control, transmission, and steering.

RESCUE BOAT AND DAVIT

PROOF LOAD & OPERATIONAL TEST			Hull Number:______
Item #	**Description**	**Design**	**Actual**
1	STATIC PROOF LOAD TEST (Davit holds 4050 lbs)	No deformation (SAT/UNSAT)	
2	STATIC BRAKE TEST (Brake holds 2760 lbs)	No deformation / slippage (SAT/UNSAT)	
3	DYNAMIC LOAD TEST: (1650 lbs in boat)		
	Boat lowers properly	(SAT/UNSAT)	
	Brake stops boat, and holds weight	(SAT/UNSAT)	
	Winch hoists boat and weight properly	(SAT/UNSAT)	
	MOTOR		
	Volts:	460 (±23 Volts)	
	Amps: Phase A	< 16	
	Amps: Phase B	< 16	
	Amps: Phase C	< 16	
	Rotation:	SAT/ UNSAT	
	RPM:	1780 (±70 RPM)	
	Cold Insulation Resistance:	>1MΩ	
	Hot Insulation Resistance:	>1MΩ	
	Bearing Temp:	SAT/ UNSAT	
	Frame Temp:	SAT/ UNSAT	
	OBSERVATIONS		
	Noise:	SAT/ UNSAT	
	Vibration:	SAT/ UNSAT	
	Casing Temp:	SAT/ UNSAT	
	Lubrication: (gearbox level)	SAT/ UNSAT	
4	FAIL-SAFE DEVICES		
	Hoist limit switch	SAT/ UNSAT	
	Operation of emergency disconnect	SAT/ UNSAT	
5	LAUNCH AND RECOVERY TEST		
	Boat lowers via remote control wire	SAT/ UNSAT	
	Brake operation via remote control wire	SAT/ UNSAT	
	Boat successfully launched	SAT/ UNSAT	
	Boat recovery and hoist	SAT/ UNSAT	
	Operation of hand crank to raise boat	SAT/ UNSAT	
	Proper fitup in stowage arrangement	SAT/ UNSAT	

PROOF LOAD & OPERATIONAL TEST			Hull Number:______
Item #	**Description**	**Design**	**Actual**
6	RECUE BOAT OPERATION		
	Throttle control	SAT/ UNSAT	
	Transmission	SAT/ UNSAT	
	Steering	SAT/ UNSAT	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE ANCHOR WINDLASS		
CHECKED			
APPROVED	DRAWING NUMBER		REV
	461-344- 8826		DRAFT
DATE	SCALE: NONE	SIZE: A	SHEET 1 OF 4

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the anchor windlass / mooring winch units. The operational test of the system will prove proper operation of the following equipment:

1.1 Two (2) combined anchor windlass / mooring winch units each complete with cable lifter(1), mooring drums(2), and warping head(1).

1.2 One (1) Electrohydraulic power pack, with two (2) pump/motor units, mounted below decks in the forecastle.

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section M-28.2

2.2 American Bureau of Shipping, Rules for Building and Classing Steel Vessels Part 1/2.3, 4/1.11.1

2.3 Det Norske Veritas, Rules for Classification of Ships, Part 3/3-36

2.4 Lloyd's Register, Classification of Ships, Part 3/13.7

2.5 Japanese Industrial Standard 6714-95

2.6 OCIMF Mooring Equipment Guidelines for the Mooring of Large Vessels.

2.7 Mooring Arrangement Fwd. - Dwg. No. 7250-331-4764 Rev. -

2.8 Mooring Arrangement Midship. - Dwg. No. 7250-331-4765 Rev. -

2.9 Mooring Arrangement Aft. - Dwg. No. 7250-331-4766 Rev. -

2.10 Tech Manual - Combined anchor windlass / mooring winch unit - with cable lifter, mooring drums, and warping head.

3 TEST INSTRUCTION

3.1 **No Load Test -** Ensure the hydraulic system is filled and vented, and align the system for normal operation. The no load test is to be performed prior to loading the anchor and anchor chain. Perform the no load test by operating the windlass once in the normal direction and once in the reverse direction for a sum of 30 minutes at rated speed. During the no load test all remote and local controls shall be demonstrated. The cabaility of each pump/motor to run each windlass and winch shall be proven. Record all operating data, as listed, on data sheets provided.

3.2 **Operational (Load) Test -** The load testing of the anchor windlass will be carried out as part of the Sea Trial Test Procedure - 8930. Verification of working load and overload capacity is to be verified at the manufacturer's facility.

3.3 **Brake Test -** The normal functioning of the brake shall be demonstrated on the windlass running under no load. Record all operating data, as listed, on data sheets provided. The holding power of the cable lifter shall be verified by the manufacturer either by test or by calculation at his facility. Onboard operational testing of the holding capacity shall be demonstrated as part of the Sea Trial Test Procedure - 8930.

FORWARD ANCHOR WINDLASS / MOORING WINCH

NO LOAD OPERATIONAL TEST			Hull Number:______
ITEM NUMBER		**1**	**2**
Description	**Design**	**Actual**	
MOTOR		PUMP / MOTOR #10	PUMP / MOTOR #11
Volts:	460 (±23 Volts)		
Amps: Phase A	< 130		
Amps: Phase B	< 130		
Amps: Phase C	< 130		
Rotation:	SAT/ UNSAT		
RPM:	1780 (±70 RPM)		
Cold Insulation Resistance:	>1MΩ		
Hot Insulation Resistance:	>1MΩ		
Bearing Temp:	SAT/ UNSAT		
Frame Temp:	SAT/ UNSAT		
HYDRAULIC PUMP/SYSTEM OBSERVATIONS			
Noise:	SAT/ UNSAT		
Vibration:	SAT/ UNSAT		
Casing Temp:	SAT/ UNSAT		
Hydraulic System Leakage:	None		
Lubrication:	SAT/ UNSAT		
System relief valve setting	650 psi +0/-65		
Oil level switch on hydraulic tank, alarm/shutdown	SAT/ UNSAT		
High oil temperature alarm/shutdown	175° F (80°C)		
ITEM NUMBER		**3**	**4**
WINDLASS OPERATION		WINDLASS #1	WINDLASS #2
Brake functioning	SAT/ UNSAT		
Clutch functioning	SAT/ UNSAT		
Local control function	SAT/ UNSAT		
Remote control function	SAT/ UNSAT		
WITNESSED BY:	SHIPBUILDER		
	CUSTOMER		

NO LOAD OPERATIONAL TEST			Hull Number:______
ITEM NUMBER		**5**	**6**
MOORING WINCH OPERATION		WINCH #10	WINCH #11
Brake functioning	SAT/ UNSAT		
Clutch functioning	SAT/ UNSAT		
Local control function	SAT/ UNSAT		
Remote control function	SAT/ UNSAT		
WITNESSED BY:	SHIPBUILDER		
	CUSTOMER		

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE ACCOMMODATION AND PILOT LADDERS	
CHECKED		
APPROVED	DRAWING NUMBER	REV
	461-344- 8855	DRAFT
DATE	SCALE: NONE · SIZE: A	SHEET 1 OF 3

NSRP

Marine Systems Division
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1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the accommodation and pilot ladders. The operational test will prove proper operation of the following equipment:

1.1 Two (2) self-stowing accommodation ladders

1.2 Two (2) pilot rope ladders with air driven winding reels

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section H-29

2.2 American Bureau of Shipping, Certificate of Construction and Survey of Cargo Gear on Merchant Vessels, Part 3.3.1, 3.3.4

2.3 SOLAS Part V/17

2.4 Japanese Industrial Standard 2621, 22-85

2.5 46 CFR 97.90

2.6 SNAME Technical and Research Bulletin 3-39 - Guide for Shop and Installation Tests, paragraph 4.29.2.1

2.7 Accommodation Ladders Arrangements and Details. - Dwg. No. 7250-331-4767 Rev. -

2.8 Tech Manual - Accommodation Ladders.

3 TEST INSTRUCTION

3.1 **Accommodation Ladder Operational Test -** From the fully stowed position, lower and fully rig the accommodation ladder. From the deployed position, unrig and hoist the ladder into its stowage. Verify that the ladder deploys and stows smoothly with no binding, unusual noise or vibration, and that the limit switches function properly. Record all operating data, as listed, on data sheets provided.

3.2 **Static Load Test -** The static load testing of the accommodation ladders will be carried out at the manufacturer's facility. If the test is not performed at the manufacture's facility it shall be accomplished onboard in accordance with reference 2.6.

3.3 **Pilot Ladder Test -** With the accommodation ladder fully rigged, demonstrate the operation of the pilot ladder air winches by deploying and stowing the pilot ladders. Verify that the pilot ladder is long enough to reach the water's edge when the ship is in the light ship condition. Verify that the location of the pilot ladder is compatible with the location of the accommodation ladder, and that the slope angle of the accommodation ladder is less than 55 degrees at the point at which it meets the pilot ladder..

ACCOMMODATION AND PILOT LADDERS

	OPERATIONAL TEST		Hull Number:______
ITEM NUMBER		**1**	**2**
Description	**Design**	**Actual**	
ACCOMMODATION LADDER		Port	Starboard
MOTOR			
Volts:	460 (±23 Volts)		
Amps: Phase A	< 6		
Amps: Phase B	< 6		
Amps: Phase C	< 6		
Rotation:	SAT/ UNSAT		
RPM:	1780 (±70 RPM)		
Cold Insulation Resistance:	>1MΩ		
Hot Insulation Resistance:	>1MΩ		
Bearing Temp:	SAT/ UNSAT		
Frame Temp:	SAT/ UNSAT		
OBSERVATIONS			
Noise:	SAT/ UNSAT		
Vibration:	SAT/ UNSAT		
Casing Temp:	SAT/ UNSAT		
Lubrication: (gearbox level)	SAT/ UNSAT		
Operation of limit switches	SAT/ UNSAT		
Drum rotation correct	SAT/ UNSAT		
Static load (Manufacturer’s Test)	SAT/ UNSAT		
PILOT LADDER OPERATION			
Deploys and stows properly	SAT/ UNSAT		
Air winch operation	SAT/ UNSAT		
Length sufficient (reaches waterline)	SAT/ UNSAT		
Compatible with accommodation ladder	Accomm. Ladder angle <55°		
WITNESSED BY:	SHIPBUILDER		
	CUSTOMER		
	DATE		

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

HULL NO	SHIPS NAME	BUILDING YARD
SUBMITTED TO	DATE	APPROVED

NATIONAL SHIPBUILDING RESEARCH PROGRAM
1,OOO,OOO BBL CRUDE OIL TANKER

DRAWN	TITLE: TEST PROCEDURE CARGO HOSE HANDLING CRANES	
CHECKED		
APPROVED	DRAWING NUMBER	REV
	461-344- 8856	DRAFT
DATE	SCALE: NONE SIZE: A	SHEET 1 OF 3

NSRP

Marine Systems Division
Univ. of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, MI 48109-2150

1 PURPOSE / EQUIPMENT TESTED

To demonstrate the proper installation and operation of the cargo hose handling cranes. The operational test will prove proper operation of the following equipment:

1.1 Two (2) 360 degree, 15 metric ton, electro-hydraulic cargo hose handling cranes.

2 REFERENCES

2.1 1,000,000 bbl Crude Oil Tanker Specification, section H-24

2.2 American Bureau of Shipping, Guide for Certification of Cranes 1987, Section 5

2.3 Det Norske Veritas - Rules for Classification, 6/1-7

2.4 SNAME Technical and Research Bulletin 3-39 - Guide for Shop and Installation Tests, paragraph 4.27.2

2.5 General Arrangement - Dwg. No. 7250-341-7008 Rev. -

2.6 Tech Manual - Cargo hose handling cranes

3 TEST INSTRUCTION

3.1 **Proof Load Test -** The proof load testing of the hose handling cranes will be carried out using known moveable weights. The proof is equal to the SWL plus 25%, for these cranes the proof load is 18.75 metric tons. Demonstrate the cranes ability to handle the proof load through all conditions representing intended service. Verify hoisting, luffing, slewing, and lowering throughout the entire range of travel. Observe for any signs of permanent damage or deformation. Record all operating data, as listed, on data sheets provided.

3.2 **Brakes and Fail-safe Devices -** Demonstrate the operation of the brake under simulated loss of power conditions. Prove proper operation of the emergency manual stop. Verify the proper operation of safeties and fail-safe devices IAW reference 2.6. Record all data, as listed, on data sheets provided.

3.3 Demonstrate proper fitup of boom and hook in the stowage arrangement Record results on data sheets provided.

HOSE HANDLING CRANES

PROOF LOAD & OPERATIONAL TEST			Hull Number:______
ITEM NUMBER		**1**	**2**
Description	**Design**	**Actual**	
CARGO HOSE HANDLING CRANE		Port	Starboard
MOTOR			
Volts:	460 (±23 Volts)		
Amps: Phase A	< 125		
Amps: Phase B	< 125		
Amps: Phase C	< 125		
Rotation:	SAT/ UNSAT		
RPM:	1780 (±70 RPM)		
Cold Insulation Resistance:	>1MΩ		
Hot Insulation Resistance:	>1MΩ		
Bearing Temp:	SAT/ UNSAT		
Frame Temp:	SAT/ UNSAT		
OBSERVATIONS			
Noise:	SAT/ UNSAT		
Vibration:	SAT/ UNSAT		
Casing Temp:	SAT/ UNSAT		
Lubrication: (gearbox level)	SAT/ UNSAT		
PUMP PRESSURE READINGS			
Slewing			
Luffing			
Hoisting			
ITEM NUMBER		**3**	**4**
BRAKES AND FAIL-SAFE DEVICES			
Brake holds load upon loss of power	SAT/ UNSAT		
Operation of emergency manual stop	SAT/ UNSAT		
Hook overtravel safety	SAT/ UNSAT		
Hydrualic oil low level float switch	SAT/ UNSAT		
Hydrualic oil over-temperature switch	80°C ±2°C		
Hydrualic pump relief valve setting	276 bar ±2.8 bar		
ITEM NUMBER		**5**	**6**
Proper fitup in stowage arrangement	SAT/ UNSAT		

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Trip Reports

NSRP 0534 Project 6-95-1

Prepared For:
William G. Becker
NSRP Program Manager for
Panel SP-6 Marine Industry Standards

Submitted On:
October 1, 1998

By:

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Introduction/Abstract

The intent of this project is to investigate and evaluate testing requirements and test criteria as outlined by the Classification Societies and Regulatory Bodies (CSARB), and to develop a mutually agreeable test program which includes a test plan and test procedures.

Objective

The focus of Task 2 was to identify CSARB restrictions to testing during certain phases of construction, and establish a test schedule that will satisfy the requirements and restrictions of the CSARB.

The Test Plan developed for Task 3 is comprised of the documentation, processes, and measures used to effectively test, inspect, and commission a new vessel.

Task 4 requires the development of a standard set of test procedures. Test procedures have traditionally been instructions used to set-up, start, and demonstrate satisfactory operation of the ship equipment and machinery to the customer and CSARB.

Approach and Rationale

To better understand the current industry practices regarding testing and inspection the project team visited foreign shipyards to witness their testing programs. Through a review of current commercial ship test plans and visits to the various shipbuilding facilities the team gained an understanding of the worldwide standard of ship testing requirements.

Shipyards Visited

The project team visited three Northern European shipyards, and although each shipyard is building a unique product, there exists many processes and procedures with respect to testing which can be considered common.

Detailed Trip Reports outlining the findings of these visits are included as attachments to this report.

Findings

The following summaries serve to highlight the key similarities and differences discovered by the project team.

Test Organization

The Test Engineering function at all three shipyards is integrated into the Design and Production Departments, known commonly as the *Commissioning Department.* This independent group performs, and often writes the test procedures. Additionally, all three shipyards benefit from extensive vendor participation in the test and commissioning process. Generally a manufacturer's representative will accomplish most of the start-up procedures for major components (per purchase agreement).

Design/Test Interface

Advanced planning for partial testing, or incremental testing is not prevalent. Incremental testing is not planned nor accomplished. The only example of design for testing that was discovered was the design addition of temperature and flow nozzles for sea trial measurements.

The Design Departments are generally responsible for miscellaneous vibration, noise, and maneuvering and speed trials testing. The Design Departments are also responsible for obtaining technical information required for testing from the vendors and regulatory bodies.

Test Procedure Format

As a general rule our European counterparts tend to keep the scope and content of their test procedures written as vague as possible. The test procedures contain data sheets, not detailed test instructions. Occasionally, a one or two paragraph description of the test instruction and set-up are included. The total quantity of test procedures is also considerably less than a typical U.S. test program.

Test Procedure Development

Typically test procedure development starts with the basic information from a previous contract (baseline). However, each shipyard has a different group responsible for writing test procedures. Often test procedures are written by Design Groups or Commissioning Engineers. Other times the test procedures are written and performed by the Quality Assurance group, including subcontractor tests.

Production Interface

In all three shipyards visited only minimal testing is done during the early outfitting stages or prior to launch. The team did not witness any pre-assembly, on-unit, or on-block testing. Partial system testing is not done, only complete system testing in the later stages of construction is accomplished. The team did not see any special fixtures or jigs made specifically for testing.

Factory testing is considered very important and is usually witnessed by a Commissioning Engineer or Shipyard Quality Assurance Representative. However, the shipyards do not rely on factory testing only. Components tested under factory test conditions are also verified under shipboard conditions to ensure reliability at sea trials. Heat runs on motors in addition to the factory heat runs are not required and are generally not done.

Pipe Hydrostatic testing

Hydrostatic testing is not outlined in a test procedure, the hydrostatic testing requirements are contained in a separate booklet. Hydrostatic testing is generally not done on partial systems, and is usually accomplished as a complete system test onboard. Joints are left unpainted prior to test in some shipyards, painted in others. System piping diagrams are marked as the hydrostatic testing is completed by the Production Department as a means of tracking completion progress.

Test Plan and Schedule

The Test Plan commonly used by U.S. and Asian shipyards does not exist in the three shipyards visited. Similar information is contained in the shipbuilding specification, and therefore a separate document is not required.

The Test Schedule and Sea Trial schedule are usually developed by the Commissioning Department. Testing duration is not standard and ranges from 3.5 weeks to 12 weeks. The duration of sea trials can last anywhere from an 18 hours, to six days.

Classification Society, Regulatory Body and Customer Requirements

The project team did confirm the existence of a set of *Standard Test Procedures* satisfying multiple CSARB requirements. This finding is directly related to the development of the *Standard Test Procedures* for Task 4. As the team had predicted, the *Standard Test Procedures* satisfied the requirements of multiple CSARBs, yet were applicable only to a specific ship type.

Two examples of a *Standard Test Procedures* were cited. In one case a ship design and test program developed using Lloyd's Rules was also acceptable to DNV for follow-ships of the same design. In a similar case, a ship design and test program developed using Lloyd's Rules was accepted by the ABS for the later ships of the class.

In all the shipyards visited it was stated that the Owner /Customer has minimal input into the test procedure development process. Generally if the shipyard has satisfied the requirements of the CSARBs, and has fulfilled the shipyard's own self-imposed test requirements, the Owner/Customer is satisfied

Documentation and Software

The project team did not witness the use of any specialized software for computer tracking or test procedure call-outs. Moreover, test procedure call-out systems

are generally not computerized. Notice of testing is given to the customer or surveyor via phone or fax.

With regard to test procedure completion tracking (progress), all test procedures are weighted evenly.

As previously stated, factory testing is considered very important and vendors must provide factory test results to the shipyard.

Results

Based on the information gathered during the Northern European trip, and information from previous trips to Asian shipyards the project team has developed a set of *Standard Test Procedures.* These test procedures, developed for Task 4, reflect the current industry trends in several ways:

- There is a reduced quantity of test procedures and subdivisions (line items).
- The new test procedures are *Standard*, and satisfy the requirements of all the CSARBs.
- Additionally, the new test procedures are modified to reduce the scope and to outline only test requirements and expected results. Test set up and test instruction is no longer included.
- The new test procedure format allows the production test engineers to provide the necessary expertise to operate the equipment in such a way as to demonstrate the required test parameters.
- There is an increase in vendor involvement in the testing program.
- The new test procedure format includes only the following categories:
    - Purpose/Equipment Tested
    - References
    - Test Instruction
    - Data Sheets

Projected Benefits

Implementation of the test procedure format modifications will reduce cycle time for testing, decrease redundant testing, decrease test related design effort and rework, and give production test engineers (commissioning engineers) control of test operations to utilize the most efficient methods available.

ATTACHMENTS:
A) Northern European Shipyard #1 Trip Report
B) Northern European Shipyard #2 Trip Report
C) Northern European Shipyard #3 Trip Report

National Shipbuilding Research Program
Panel SP-6 - Project 6-95-1
Standard Commercial Ship Test And Inspection Plan, Procedures, And Database
Trip Report - Northern European Shipyard #1

A. General Design Information

1) Shipyard #1 builds Ro/Ro ferries, small passenger ships, and multipurpose offshore support vessels and dredges. They have a total workforce of about 1200, half of which are sub-contractors. Most outfitting, and 30-50% of their steel fabrication work is subcontracted. They have a very low turn over rate of personnel and their wages tend to closely match that of the surrounding area. Their general attitude towards overtime is that it should be used where appropriate to cut the length of the schedule.

2) Organization - There is no individual Test Engineering department. All test procedures are written by the commissioning engineers under the commissioning manager, a department of about six people. The commissioning engineers are basically machinery operating engineers with offshore operational backgrounds. Along with the engineers, there are 5 to 10 machinists to assist in performing the testing. Electrical testing is completely subcontracted (both power and automation). Electrical testing also relies heavily on OEM vendors for start-up support and assistance. The scope and content of the test procedure are kept as vague as possible so that the actual performance of each test is left up to the commissioning engineers. The commissioning manager maintains a good relation with the project engineer.

3) It takes a total of about 12 months to deliver a ship from design (3mo) to completion for a standard design. The team was allowed to tour one of their new offshore support vessels (flexible pipe layer). These ships are approximately 120 meters long, and have two independent engine rooms with a pod type propulsion system. This ship was due to go on sea trials in 4 days. There was obviously much work still remaining in the areas of electrical hookup and testing. We observed modifications and installation still being made to the main propulsion consoles on the bridge and technicians had disconnected a large number of wires in automation control boxes. Discussions with the commissioning officer revealed that they were currently having trouble with the load management system.

4) For design development the subcontractors are allowed in the shipyard to use their cad systems.

Note: Answers to questions are in blue (dark) type.

5) What types of ships is your shipyard currently building?
   a) Tankers
   b) Containerships
   c) Cruise or **Passenger Ships/Ferries**
   d) Bulk Carriers
   e) Roll-on / Roll-off
   f) Other (explain) - see above

6) What regulatory bodies or Classification Societies govern the construction and test of your commercial vessels? (Circle all that apply)
   a) American Bureau of Shipping
   b) Det Norske Veritas
   c) Lloyd s Register of Shipping
   d) Japanese Industrial Standards

e) Code of Federal Regulations 46
f) International Maritime Organization - SOLAS Conventions
g) American Society of Testing and Materials - Volume 01.07
h) Bureau Veritas (French)
i) Germanischer Lloyd
j) Other (explain) ____
____

7) Does additional testing not specifically required by the regulatory bodies or classification societies exist to satisfy internal, customer, or guarantee requirements?
   a) No
   b) Yes (explain) - Internal company requirements instituted to promote reliability.

8) Is system testing considered when determining the initial design of shipboard systems?
   a) No
   b) Yes (explain) - On cooling water systems flow and temperature nozzles are added for sea trial measurements and then later plugged, nothing for flushing was added.

9) In what ways do detailed systems designs accommodate testing requirements?
   a) Flanged piping connections to facilitate hydrostatic testing.**-no extra**
   b) Additional fittings to accommodate flushing and hydrostatic testing **- only as above, and for hydros sometimes blind flanges are used.**
   c) Additional electrical test connections to simulate operational conditions. **no extra.**
   d) Other (explain) ____
____

B. Test Plan - The test plan as we know it does not exist, much of the information is contained in the specification, the test plan is more of a schedule. The schedule is basically LAUNCH + 2 to 3 weeks for shaft alignment (twin screw), Cooling systems initial start-up, Generator resistive load testing, Generator power available to Switchboard is critical due to minimal shore power design. The total test period is 12 weeks, with the intention to drive this down to 8 weeks for a standard design vessel.

1) Does the Test Plan include inspection and quality control, or are those functions addressed in separate documents?
   a) Test Plan is all inclusive.
   b) Inspection Control Plan exists
   c) Quality Control Plan exists
   d) Other (explain) - QA does mostly weld procedures.

2) How much input, if any, does the owner/customer have in the development of the Test Plan?
   a) Owner/customer has no input.
   b) Owner/customer has only minimal input or review/approval authority.
   c) The Test Plan is a joint effort between owner/customer and shipbuilder.
   d) The Test Plan is developed solely from a owner/customer specified procedure.
   e) Other (explain) ____
____

3) Is the Test Plan developed to a level of detail which will allow a test schedule to be generated from the Test Plan, or is the schedule developed independently?
   a) Test Plan generates test schedule.
   b) Test schedule is generated independently.
   c) Other (explain) test plan is a schedule.

C. Test Procedures - Test procedures do not have instructions, only data sheets. Test procedure development always starts with the basic information from another vessel, because most systems are common. Test procedure development takes about six months. Only very limited testing is done before launch. Generators are tested by the vendor (basic factory testing) and retested onboard during initial start-up (salt box testing) and again during final sea trials using ship's load. Vendors must provide factory testing results, and this information is forwarded to the customer. There is a 14 day approval cycle for test procedures as with all drawings, for Classification Society and for Owner. There are approximately 40 Test procedures per vessel, this more closely resembles U.S. process rather than Japanese processes. There is a large vendor participation in the Test and Commissioning Process, and the commissioning team attends most of the factory testing.

1) Do standard test procedures which meet the criteria of multiple Classification Societies and Regulatory Bodies exist for selected systems? If yes, which test procedures, and which Classification Societies and Regulatory Bodies?
   a) No
   b) Yes (explain) - A single ship design and test program has been used for both Lloyd s and DNV. Lloyd s ship was built first, sister ship was built under DNV rules (DNV was forced to accept Lloyd s approved design where there were different criteria).

2) Do the test procedures clearly identify if incremental (component level, or partial system) testing for a system can be performed?
   a) No (not designed for incremental testing, systems tested as a whole upon completion)
   b) Yes (explain) ____
   ____

3) Which of the following statements is true concerning hydrostatic tests of piping systems?
   a) Hydrostatic tests of piping systems are included in one single test procedure.
   b) Each separate system is hydrostatically tested as part of the system operational test.
   c) Hydrostatic tests are included as part of the inspection plan or quality plan.
   d) Other (explain)Hydros are done separately, and are included in a stand alone test booklet. all joints are left unpainted and a system diagram is marked as each section of pipe is tested as a completion record. We observed that pipe insulation was not installed until late in the construction cycle (so as not to interfere with hydro tests).

4) Is final operational testing accomplished during a single sea trial or are sea trials accomplished in two general parts, a builders trail and a final acceptance trial?
   a) Single sea trial. Usually about 110 persons per sea trial, 35 subcontractors, 20 production , 20 owners/operators, and the balance is office personnel (engineers, project mgt.). Sea trials are usually about 30 hrs. The owners are required to turn over all discrepancy lists at the conclusion of sea trials and the ship is delivered approximately one week later.
   b) Two part sea trial.

c) Other (explain) ____
____

5) What are the categories used for subdivision of test procedures? (Circle all that apply)
   a) Hull
   b) Machinery
   c) Electrical
   d) Accommodation
   e) Outfitting
   f) Other - Not subdivided, individual system procedures.

D. Production/Test Interface

1) Are portions of test procedures completed separately as the associated systems and components are ready, or do you find it is best to wait for a completed system and accomplish testing all at once?
   a) Portions of test procedures are completed separately.
   b) Testing is best accomplished one time on completed system.
   c) Other (explain) - Manufacturer s factory testing is accomplished where possible, then usually re-tested under practical conditions. Manufacturer s are doing less factory testing to decrease costs. Testing at shipyard is done prior to sea trials (as redundant testing for proof of reliability).

2) What group has the responsibility of performing hydrostatic testing and flushing of piping systems?
   a) Fabrication/production group.
   b) Operational test group (commissioning crew) drives testing, including pipe shop spools.
   c) Other (explain) ____
   ____

3) During what phase of construction are hydrostatic tests done on partial systems prior to system completion?
   a) During pipe fabrication.
   b) During on-ground outfitting.
   c) During on-board outfitting.
   d) Hydrostatic testing is not done on partial systems.
   e) Other (explain) A, B C above

4) Are heat runs accomplished on new motors? If so, what is the required duration of these heat runs?
   a) 15 minutes.
   b) 30 minutes.
   c) 1 hour.
   d) Until normal operating temperatures are reached
   e) Heat runs are not required.
   f) Other (explain) - Only if ship s gages are installed are readings taken, heat runs are done by factory only.

5) If heat runs are done, is it due to a classification society or regulatory body requirement?
   a) No.
   b) Yes. (explain)____
   ____

6) What parameters are monitored during a heat run? (Circle all that apply)- **DNA**
   a) Current
   b) Voltage
   c) Frame temperature
   d) Bearing temperature
   e) Pump suction pressure
   f) Pump discharge pressure
   g) Motor RPM
   h) Other (explain) ____
   ____

7) Which statement is true concerning effectiveness and cost efficiency?
   a) It is better to accomplish tests in earlier stages of construction.
   b) It is better to accomplish a majority of testing during the dock trial and sea trial?
   c) Other (explain) ____
   ____

8) Are all systems pre-tested by the shipyard prior to official testing done in the presence of a classification society or regulatory body surveyor?
   a) Yes
   b) No
   c) Certain critical systems are preliminary-tested

9) Does your facility utilize any special test fixtures or apparatus to facilitate system testing or partial system testing in the earlier stages of construction?
   a) No
   b) Yes (explain) ____
   ____

E. Waterborne Testing & Sea Trials

1) Waterborne (overboard) testing is accomplished after the ship is launched, and after production work is completed, but prior to dock and sea trials. What is the typical duration of waterborne testing?
   a) 6 weeks
   b) 8 weeks (goal for future work)
   c) 10 weeks
   d) 12 weeks (typical waterborne test window)
   e) Other - For newer vessels (larger vessels, complicated design dredges) the window will go to 15 weeks.

2) What is the single determining factor with respect to testing that influences this duration (critical path)?
   a) Main propulsion testing.
   b) Electrical power generation testing.
   c) Automation /controls testing (current vessels have 800 I/O points, large ferries has up to 2000 points).
   d) Hull/deck equipment testing.
   e) Auxiliary systems testing
   f) Accommodation testing
   g) Other (explain) ____
   ____

3) What ways would you recommend to reduce cycle time related to waterborne (overboard) testing? **Explain - Alarm and monitoring systems are the critical path now.**

F. Documentation & Software

1) To what extent has your shipyard incorporated computer technology and specialized software into the tracking and documentation of test requirements?
   a) Computers are not used.
   b) A single database program tracks test requirements and completed test items.
   c) Several databases are used to track test requirements and completed test items.
   d) Other (explain) - None, test call-outs are not automated.

2) Is there a specific software package used to establish and track test procedures and test requirements?
   a) No, small test group maintains control of tracking manually.
   b) Yes (explain)

3) Is there a system or method in place (computer or other) to prevent duplicate or redundant testing?
   a) No. (see above)
   b) Yes (explain) ____
   ____

4) Has your company identified any regulatory body or classification society rules that restrict testing to the final phases of construction? If so, how is this information disseminated in the company?
   a) No.
   b) Yes. (explain) ____
   ____

5) Are documentation requirements for partial testing different from complete system testing documentation requirements?
   a) No. (partial system testing is not done)
   b) Yes. (explain) ____
   ____

6) From what source are documentation requirements for partial/incremental testing developed? (Circle all that apply)
   a) From owner's requirements.
   b) From classification society rules.
   c) From regulatory body rules.
   d) Other (explain) - From the shipyard s pre-existing standards, and may be modified for a new ideas in cost savings and ease of work by production input (example - pipe hydros which are too difficult to perform on board may be shifted to the shop.

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Standard Commercial Ship Test And Inspection Plan, Procedures, And Database
Northern European Shipyard #2

General - Shipyard #2 is a small new construction yard located in Northern Germany, their primary concentration is on small containerships.

- The yard was almost bankrupt in the mid 1980's when it was bought by a ship owner. The management was completely changed based on the Japanese style.
- Since that time the yard has been profitable, and only recently have they started upgrading their facilities.
- Their design and production functions are completely linked by a computer network, however they do not feel that a single system such as Tribon is the way to go. They employ several smaller computer systems that are linked and also are easily upgradeable.

Testing - The test function is performed by the QA department. Steel accuracy and inspection during construction are the primary functions. The emphasis of their test program is to maximize efficiency and productivity through accuracy control. Very little was said about their operational and machinery test program. Their current test philosophy is to reduce the testing done by the test organization, and put the responsibility on the production workers.

- Owner Reps are usually given an office at the facility and are given 24 hours notice for testing events. The classification society surveyors are local and are also given 24 hours notice. Notice is given via phone or fax, there is no computer call out system.
- Sea trials last for 18 to 24 hours.

General Organization - Four major departments affect the testing of the ships:

- Planning - Subdivided into two groups, Main Planning, and Detail Planning, both working in the production areas closely with the production workers.
- Design - Responsible for technical information and specifics required for test procedures.
- Quality Assurance - Writes and performs the test procedures, in addition to their functions as inspectors in the steel accuracy area. The QA department is made up of 17 persons, 8 of which are responsible for steel production, 3 function as production foreman, and 1 as a guarantee engineer.
- Production - Production workers are responsible for the testing of their own work, but this did not appear to apply to system or operational testing.

Test Organization - The Design Department determines the test requirements based on the regulatory body and classification society requirements. This information is then given to the QA department who are responsible for writing the test procedures. The design group also is responsible for gathering test requirement data from subcontractors. There is a very close relationship between the QA, Production, and Design Departments.

Test Types - There are several types of testing done for each ship.

- General Tests are those tests that are in the Specification and are required to satisfy the customer requirements, these tests may include speed, endurance, and cargo capacity. This testing is always done with a customer witness.
- Classification Society Testing includes the requirements of the Regulatory bodies.
- Internal testing prior to official call out is done to ensure performance when classification society surveyors are present.

Test Procedures - There does exist standard test procedures that satisfy the requirements of several regulatory bodies, however they do require modification to suit each specific ship design.

- They have built U.S. flag ships for American companies to ABS and USCG rules and feel that to build and test ships to ABS Standards requires no special effort from their usual procedure. However, The USCG requirements are often burdensome and out dated. Their experience shows that the USCG approval process is a major roadblock for trying to get approval for new equipment. The ACP may preclude this problem.
- The format of their test Procedures is similar to the format of many of the Asian yards we have visited. A short 1-2 paragraph test description outlines required system alignment and necessary procedures. The references are listed, including tech manuals, and followed by detailed data sheets.
- The test procedures are written by the QA department and require the signature of the customer, classification society, and the QA witnesses.

Test Reports - The Test Reports are in four separate volumes:

- Steel Production/Quality Requirements
- Accuracy Reports
- Mechanical Test Procedure Reports
- Subcontractor Steel Fabrication Test Results.

Subcontractor Testing - Subcontractor testing done outside the facility on major components is always witnessed by a shipyard QA representative. This is also true for time critical parts such as propellers and shafts. The QA department generally develops the test procedures for the subcontractor, and the shipyard performs the tests.

Production - Their production efforts closely resemble their Japanese model and place a large emphasis on process control, accuracy control, and just in time material acquisition. They have integrated Planning and Production into the initial design process by use of multidisciplinary task forces.

- The bridge and deck house areas are built in Eastern Europe to capitalize on the cheap labor rates. They are shipped as complete units to the yard just in time.
- The ship is launched without the main engine and most engine room componentry, the main engine is then installed dockside in what appears to unitized construction. There is however no preliminary testing accomplished on the units except for hydrostatic testing of piping.
- A crane is hired for only one day to install the main engine and the deck house. This is accomplished the same day the ship is launched.
- Their cycle time for ship construction is as follows:
    - 30 working days from keel to launch
    - 30 working days for outfit and test.

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Trip Report - Northern European Shipyard #3

A. General Design Information

1) Shipyard #3 builds large containerships primarily for their parent company. They deliver 4-5 ships per year and have about 3000 workers at this facilty. All together they have a total workforce of about 9000, many of which work in their other yards. They are presently building the 11th vessel of a 15 vessel contract.

2) Organization **-** There is no individul Test Engineering Department all test procedures are written by the design engineers who are responsible for the subject systems. The commisioning department is made up of 5 commissioning engineers, (3 mech. and 2 elec.), and are connected to the Design Department. The commissioning engineers are basically machinery operating engineers with offshore operational backgrounds. The Commissioning Department is responsible for scheduling testing and coordinating the sea trials. The Commissioning Department comunicates directly with the customer and the Regulatory Bodies, they are not responsible for steel or accuracy control. The Commissioning Department is required to work overtime for the first few vessels of a class to meet schedule requirements. Sea trial and deivery schedules are key and are never missed. A separate budget is not assigned to the Commissioning Department they feel they are a necessary part of the construction/test evolution and hours expended simply reflect the size of their standard test crew, with overtime hours for problem resolution.

3) A 12 person crew of watchstanders work around the clock in 3 shifts during the testing evolution (approx. 3.5 weeks). This crew is comprised of experienced production trade personnel which have been transferrred to this role after their installation work has been completed.

4) Shaft alignment is a production function, although there is a test procedure to record the final alignment readings, and the alignment is supported by the Design Department. Alignment typicallay takes a week to ten days to complete for a a single screw vessel. Extensive use of castable chocks (Chockfast) is used. The lineshaft bearings are the only area that machined chocks are used (to allow for later adjustments).

5) It takes a total of about 60 working days to deliver a ship from design to completion for a standard design. The testing duration for quay side testing is about 3.5 weeks, usually done around the clock. After the ship is launched, completion of production work and shaft alignment takes about 1.5 weeks, and then testing can begin. The key factor for start of testing is the generator start-up evolution. Shore power is only 380v/50hz and does not support shipboard testing.

6) The manufacturers representative does most equipment start-up of major components and is always available for dockside tests and sea trials. The vendors testing at the yard is supervised by the Commissioning Department. Problems identified during testing are given to the vendor and the Design Department simultaneously for correction, this is usually done at a daily morning meeting chaired by the commisssioning manager (the Design Department is represented at these meetings by a liaison). The Design Department attends the testing during sea trials, and dockside testing is usually witnessed by the engineer responsible for that particular system.

7) The completed test procedures are collected by one person and copies are delivered to the owners. Engineering does not review the completed procedures.

8) The generators are tested at 100% load for 1 hour using resistive load banks. Generator testing on board is mostly for parralel running, transition load drops are done at the factory. All shutdowns and safeties are demonstrated to satisfy class rules on board the vessel (even if it is a repeat of factory tests). Some large components are tested at the shipyard vice the manufacturers shop, such as the motor thruster combination.

9) Sea trial vibration and noise testing is done by yard personnel, no third party contractors are required.

10) Insulation resistance tests of cable generally are not required, they rely on the manufacturer of the cable and their certifications.

Note: Answers to questions are in blue type.

11) What types of ships is your shipyard currently building?
 a) Tankers
 b) Containerships
 c) Cruise or Passenger Ships/Ferries
 d) Bulk Carriers
 e) Roll-on / Roll-off
 f) Other (explain) - see above

12) What regulatory bodies or Classification Societies govern the construction and test of your commercial vessels? (Circle all that apply)
 a) American Bureau of Shipping
 b) Det Norske Veritas
 c) Lloyd s Register of Shipping
 d) Japanese Industrial Standards
 e) Code of Federal Regulations 46
 f) International Maritime Organization - SOLAS Conventions
 g) American Society of Testing and Materials - Volume 01.07
 h) Bureau Veritas (French)
 i) Germanischer Lloyd
 j) Other (explain) - The first few ships of the class were built to Lloyd s rules, however due to owner preferences, the rest of the class will be built to ABS rules. The ABS appears to have accepted almost all the test criteria and design reqts of Lloyd s which made for a smooth transion.

13) Does additional testing not specifically required by the regulatory bodies or classification societies exist to satisfy internal, customer, or guarantee requirements?
 a) No
 b) Yes (explain) - Some special requirements by the owner are placed in the building specification. Other tests, such as flow rate to confirm orifice sizing, are done at the outfit quay to ensure the design. Heat runs are conducted on some equipment by the yard for their own satisfaction.

14) Is system testing considered when determining the initial design of shipboard systems?
 a) No
 b) Yes (explain) - But only to the extent of adding flushing connnections and spool pieces.

15) In what ways do detailed systems designs accommodate testing requirements?

   a) Flanged piping connections to facilitate hydrostatic testing.

   b) Additional fittings to accommodate flushing and hydrostatic testing.

   c) Additional electrical test connections to simulate operational conditions

   d) Other (explain) ____

   ____

B. Test Plan - The test plan as we know it does not exist, much of the information is contained in the specification, the test plan is more of a schedule.

1) Does the Test Plan include inspection and quality control, or are those functions addressed in separate documents? **Does Not Apply.**
   a) Test Plan is all inclusive.
   b) Inspection Control Plan exists
   c) Quality Control Plan exists
   d) Other (explain) -

2) How much input, if any, does the owner/customer have in the development of the Test Plan? **Does Not Apply**
   a) Owner/customer has no input.
   b) Owner/customer has only minimal input or review/approval authority.
   c) The Test Plan is a joint effort between owner/customer and shipbuilder.
   d) The Test Plan is developed solely from a owner/customer specified procedure.
   e) Other (explain) ____

   ____

3) Is the Test Plan developed to a level of detail which will allow a test schedule to be generated from the Test Plan, or is the schedule developed independently? **Does Not Apply.**
   a) Test Plan generates test schedule.
   b) Test schedule is generated independently.
   c) Other (explain) **-** The Sea Trial schedule for the first vessel of a class is done by hand, the schedules for follow ships is compute generated. After the computer schedule is generated, modifications based on production work are done by hand.

C. Test Procedures - Some test procedures do not have instructions, only data sheets, other test procedures have brief system descriptions and operational instructions. The reason for differences is simply a matter of preference by the system design engineer responsible for the test procedure. Test procedure development always starts with the basic test procedure information from another vessel, because most systems are common. Test Procedure information is often informal as tests are performed by the same group each time, however they feel that there is enough information contained in the test procedures to allow a new person to perform the tests. Generators are tested by the vendor (basic factory testing) and retested onboard during intial start-up (salt box testing) and again during final sea trials using ship's load. Vendors provide factory testing results, but this information is not forwarded to the customer unless requested. There are approximately 160 test procedures per vessel, the test procedure index is subdivided based on the numbering system used in the specification. Test procedures do require owner approval to avoid later problems. Test Report Books are subdivided into 3 sections, Pre launch (10 test procedures), Dock Trials (160 test procedures), Sea Trials (25-30 events). The shipyard is not ISO qualified, nor do they intent to make the investment in this process (their belief is that the product is a verification of their quality - not thier documentation effort).

1) Do standard test procedures which meet the criteria of multiple Classification Societies and Regulatory Bodies exist for selected systems? If yes, which test procedures, and which Classification Societies and Regulatory Bodies?
   a) No
   b) **Yes (explain) - A single ship design and test program has been used for both Lloyds and DNV. Lloyds ship was built first, sister ship was built under DNV rules (DNV was forced to accept Lloyds approved design whwere there were different criteria).**

2) Do the test procedures clearly identify if incremental (component level, or partial system) testing for a system can be performed?
   a) No (not designed for incremental testing, systems tested as a whole upon completion)
   b) Yes (explain) ____
   ____

3) Which of the following statements is true concerning hydrostatic tests of piping systems?
   a) Hydrostatic tests of piping systems are included in one single test procedure.
   b) Each separate system is hydrostatically tested as part of the system operational test.
   c) Hydrostatic tests are included as part of the inspection plan or quality plan.
   d) Other (explain) Hydros are done separately, and are outlined on a single sheet of paper which is not an official document, the test call-outs for the individul systems later become the official documentation for the owners. Hydros are not done on partial systems, the complete system is hydrostatically tested onboard after installation. Only small minor systems are hydro tested prior to installation onboard. Insulation around exhaust joints is of the removable type to allow for visual testing during operational tests.

4) Is final operational testing accomplished during a single sea trial or are sea trials accomplished in two general parts, a builders trail and a final acceptance trial?
   a) Single sea trial. Usually about 140 persons per sea trial, 12-15 of the owners crew. The ships crew is schooled by the automation vendor for about 3 weeks prior to sea trials. Sea trials are ususally about 3-6 days and include main engine inital start-up and run in time. The owners are required to turn over all discrepency lists at the conclusion of sea trials and the ship is delivered aproximately one week later. The Sea Trial schedule for the first vessel of a class is done by hand, the schedules for follow ships are computer generated. After the computer schedule is generated, modifications based on production work are done by hand.
   b) Two part sea trial.
   c) Other (explain) ____
   ____

5) What are the categories used for subdivision of test procedures? (Circle all that apply)
   a) Hull
   b) Machinery
   c) Electrical
   d) Accommodation
   e) Outfitting
   f) **Other - Subdivision based on numbering system of specification.**

D. Production/Test Interface

1) Are portions of test procedures completed separately as the associated systems and components are ready, or do you find it is best to wait for a completed system and accomplish testing all at once?
   a) Portions of test procedures are completed separately.
   b) Testing is best accomplished one time on completed system. Hydrostatic testing is done on a complete system after installation onboard. Partial testing of systems onblock are not done.
   c) Other (explain)

2) What group has the responsibility of performing hydrostatic testing and flushing of piping systems?
   a) Fabrication/production group, with supervision from the Comm. Dept.
   b) Operational test group
   c) Other (explain) ____
   ____

3) During what phase of construction are hydrostatic tests done on partial systems prior to system completion?
   a) During pipe fabrication.
   b) During on-ground outfitting, (minor systems only).
   c) **During on-board outfitting. (attempt to hydro system as a whole)**
   d) Hydrostatic testing is not done on partial systems.
   e) **Other (explain) - Piping, including joints, is painted prior to hydrostatic testing**

4) Are heat runs accomplished on new motors? If so, what is the required duration of these heat runs?
   a) 15 minutes.
   b) 30 minutes.
   c) **1 hour, only on certain pieces of equipment, at their own discretion.**
   d) Until normal operating temperatures are reached
   e) Heat runs are not required.
   f) Other (explain)

5) If heat runs are done, is it due to a classification society or regulatory body requirement?
   a) No.
   b) Yes. (explain)____
   ____

6) What parameters are monitored during a heat run? (Circle all that apply)-
   a) Current
   b) Voltage
   c) Frame temperature
   d) Bearing temperature
   e) Pump suction pressure
   f) Pump discharge pressure
   g) Motor RPM
   h) Other (explain) - Only one set of readings is taken.__________________
   ____

7) Which statement is true concerning effectiveness and cost efficiency?
   a) It is better to accomplish tests in earlier stages of construction.
   b) It is better to accomplish a majority of testing during the dock trial and sea trial?

c) Other (explain) ____
____

8) Are all systems pre-tested by the shipyard prior to official testing done in the presence of a classification society or regulatory body surveyor?
   a) Yes, most of the time.
   b) No
   c) Certain critical testing are preliminary-tested

9) Does your facility utilize any special test fixtures or apparatus to facilitate system testing or partial system testing in the earlier stages of construction?
   a) No, only the simulation software for the automation which is tested at the vendors shop. The first control consols for eash class of vessels are factory tested and remain at the vendor facility as a simulator until the units are placed on the final vessel of the class. Empty control cabinets are installed on the ship, the automation controls are tested by the vendor, and then the vendors install the compnents and do the electrical hook ups. Simulation and installation is followed by hot testing on board the vessel to ensure all automation has been properly installed. Hot testing usually requires 12 hours per day with a special crew of 3 to 4 workers assigned.
   b) Yes (explain) ____
____

E. Waterborne Testing & Sea Trials

1) Waterborne (overboard) testing is accomplished after the ship is launched, and after production work is completed, but prior to dock and sea trials. What is the typical duration of waterborne testing?
   a) 6 weeks
   b) 8 weeks
   c) 10 weeks
   d) 12 weeks
   e) Other - 3.5 weeks

2) What is the single determining factor with respect to testing that influences this duration (critical path)?
   a) Main propulsion testing.
   b) Electrical power generation testing.
   c) **Automation /controls testing (current vessels have 10,000 I/O points)**
   d) Hull/deck equipment testing.
   e) Auxiliary systems testing
   f) Accommodation testing
   g) **Other (explain) Allowing production to be finished in the time after launch, often main engine LO flushing delays starting testing earlier.**

3) What ways would you recommend to reduce cycle time related to waterborne (overboard) testing**? No Response**

F. Documentation & Software - Test Procedure completion is tracked, but each test procedure is weighted equally - timing is more important than the manhours required to complete a test procedure.

1) To what extent has your shipyard incorporated computer technology and specialized software into the tracking and documentation of test requirements?
   a) Computers are not used.
   b) A single database program tracks test requirements and completed test items.
   c) Several databases are used to track test requirements and completed test items.
   d) Other (explain). Utilize an S-curve to track testing progress.

2) Is there a specific software package used to establish and track test procedures and test requirements?
   a) No.
   b) Yes (explain)

3) Is there a system or method in place (computer or other) to prevent duplicate or redundant testing?
   a) No, it is done by hand.
   b) Yes (explain) ____
   ____

4) Has your company identified any regulatory body or classification society rules that restrict testing to the final phases of construction? If so, how is this information disseminated in the company?
   a) No.
   b) Yes. (explain) ____
   ____

5) Are documentation requirements for partial testing different from complete system testing documentation requirements?
   a) No. (partial system testing is not done)
   b) Yes. (explain) ____
   ____

6) From what source are documentation requirements for partial/incremental testing developed? (Circle all that apply)
   a) From owner's requirements.
   b) From classification society rules.
   c) From regulatory body rules.
   d) Other (explain) - partial system testing is not done

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Task 5 - Database for Tracking Testing and Acceptance

NSRP 0534 Project 6-95-1

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Introduction/Abstract

The intent of this project is to investigate and evaluate testing requirements and test criteria as outlined by the Classification Societies and Regulatory Bodies (CSARB), and to develop a mutually agreeable test program to include a test plan and test procedures. Additionally, the scope of this project includes development of a database capable of tracking testing and acceptance.

Nomenclature

Badge - The employee identification number of the individual responsible for coordinating a test demonstration.

Call out - The documentation associated with a test demonstration. Information regarding location, test supervisor, time, etc. is included, as well as the specific line items to be demonstrated. Data sheets for the specified tests are also considered part of the *call out.*

Closed - A line item or test procedure is considered *closed* when it has been successfully demonstrated.

Data point - The individual pieces of information recorded at the test demonstration are considered data points. Line items may be made up of one or more data points.

Data sheet - The portion of the test call out used for recording actual results is known as the data sheet.

Database - A series of related tables used to store all information regarding the test and inspection program including; hull designation, test procedures, line items, actual and expected data points, and call out progress reports.

Design results - The expected outcome of a test demonstration based on the system diagram, vendor information, or other source. Can be quantitative or qualitative (SAT/UNSAT).

Form - A display screen which prompts the user to enter certain required information necessary to accomplish the desired task (create call out, update data, etc.).

Input - To complete the data sheets by entering actual test results in the appropriate spaces.

Line item - The portion of a test procedure that defines the actual test demonstration. The line item may represent a single data point, or multiple related data points.

Navigation bar - The lower portion of a screen which contains links to direct the user to other associated screens or back to the main menu.

Open - A line item or test procedure is considered *open* when it has not yet been successfully demonstrated.

Report link - The associated updated data sheets for a test procedure. The test procedures, developed in *MS Word*, contain icon symbols (*report links*) which link the user to the associated data sheets.

Screen - The display of any information related to the *MS Access* database.

Test procedure - An *MS Word* document comprised of the requirements and instructions used to set-up, start, and demonstrate satisfactory operation of ship equipment, systems, and machinery to the customer and CSARBs.

Test report - A test procedure which has been executed and contains the appropriate updated data and necessary information to be considered complete is designated a *test report*. The *report link* embedded in the test report (*MS Word* document) automatically prints the associated updated data sheets for the specified test report.

Update - After the user has input the actual test results, the *Update Button* allows that information to be submitted to the database.

Objective

The objective of Task 5 is to develop a model database tracking system that can be used to track the status of each standard test procedure and vendor test procedure. The database is capable of providing updated progressing of incremental and complete testing and acceptance of shipboard systems and equipment.

Additionally, the database can be used to automate test call out of any line items for witnessing of test performance by the customer or surveyor. The system allows users to make notification of their intentions to perform a test,

record the results of the test, document the test in a test report, and track the progress of each test procedure.

The structure of the *Database for Tracking Testing and Acceptance* allows complete integration of all test documentation, call outs, data recording, and report generation. The use of compatible software greatly reduces duplicate effort traditionally associated with test documentation and tracking.

Approach and Rationale

Using other shipyards both foreign and domestic as a benchmark, the project team has examined several different types of test programs. Each shipyard investigated utilizes computers to various extents for tracking testing. The project team has incorporated the information gained from industry leaders into the development of the database for Task 5.

Software Selection

The Database for Tracking Testing and Acceptance utilizes the *Microsoft Office Professional 97 Suite* software. Specifically, the Main Database is compiled in *MS Access*, the Test Procedures are written in *MS Word*, and the forms and reports generated are a function of *MS Access and MS Word*.

The *Microsoft Office Professional 97 Suite* is a powerful tool that is readily available, and therefore is an excellent choice for *The Database for Tracking Testing and Acceptance*. The *Microsoft Office 97 Suite* is well suited for use with a PC based computer network. Unlike mainframe systems, the PC based tracking system described herein is easily modified, and can be easily upgraded.

Network System Configuration

The Database for Tracking Testing and Acceptance utilizes a PC based computer network with available terminals in key locations for end users. A generic network system configuration is depicted on Attachment (A).

Initial Database Input - Individual test procedure data sheets, line items, and data points are developed in the Main Test Database. The information contained in the database is accessible through a PC network connection. Test procedures are developed using a combination of *MS Word* and *MS Access* software to avoid duplication of effort when loading information into the Main Test database. Tables and reports constructed in *MS Access* are easily imported to *MS Word*, and included as part of the test procedures, developed in *MS Word*.

Network Connection - Using any existing PC network, remote PC terminals are placed in convenient locations throughout the shipyard. The test supervisors can log on to any PC terminal to schedule a test call out, print reports, or update test procedure data.

Customer and Regulatory Body - In addition to the remote PC terminal accessible to the test supervisors, PC terminals are also available to the customer and CSARB surveyors. From these terminal locations the surveyors may access all information contained in the database, and may preview and print all reports.

Database System Structure

The *Instructions for Tracking Testing and Acceptance Database Model,* as well as a CD ROM containing the Database Model are included with this report (Attachments B & C). The following is a brief description of the system structure and capabilities.

Main Test Database - The main test database is developed in *MS Access*, and contains relational databases necessary for tracking, progressing, and calling out test procedures. The relational databases are comprised of all the fields required to input and update expected and actual test results. Individual records in the relational databases represent unique line items for the associated test procedures.

Individual Test Procedure Line Item Call Out- End users have the ability to select individual line items from test procedures and schedule call outs for test demonstration. Upon completing the forms associated with the main database the user may submit the scheduled call out and print a

hard copy of the data sheets to record the actual results during the demonstration.

Daily Customer Call out Report - The customer and CSARB surveyors may access any of the reports available in the database system. A preview/print of the call out report identifies which line items are scheduled for demonstration on future dates.

Data Input - During the test demonstration the test supervisor records the actual test results on the test call out data sheets. This information is later input into the main database thereby keeping the database updated.

Test Procedure Progress Report - At any time, any authorized user of the system can preview/print a progress report. The progress report details which line items have been satisfactorily demonstrated, and which items remain open.

Database / Test Procedure Interrelationship

Test Procedures - Individual test procedures are developed in *MS Word* using the standard test procedures of Task 4 as a base. Each test procedure is modified slightly to suit the specific equipment in the associated design. The data sheets for each test procedure are compiled by entering the line item, data points, and expected results into the *MS Access* main database. A hypertext link embedded in each test procedure automatically displays/prints the associated data sheets for the specified test procedure. The data sheets are identical to the call out data sheets used by the test supervisor for recording the actual data during the test demonstration.

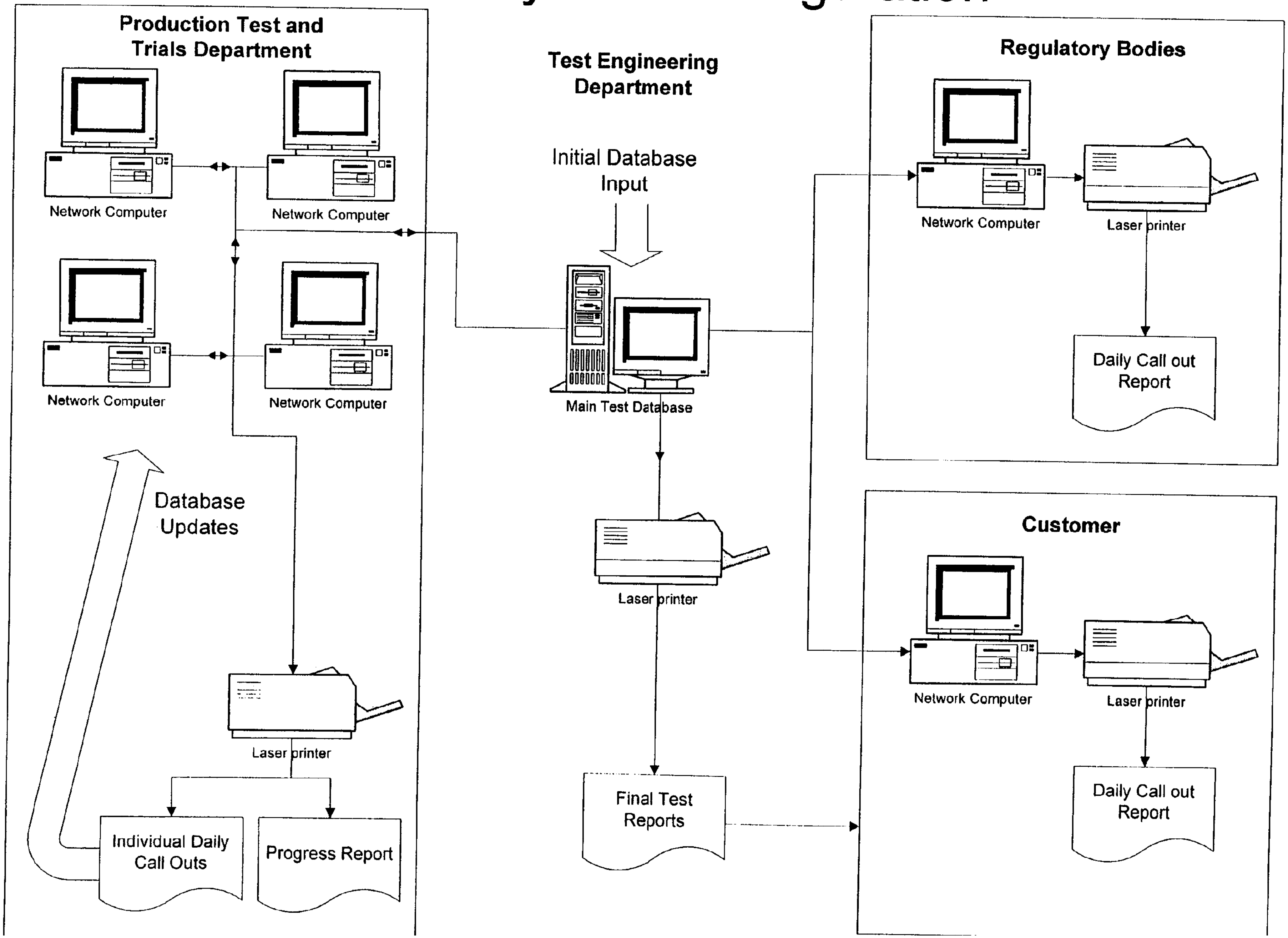
Final Test Reports - The main database is consistently updated and reflects both expected values and actual results. By simply opening the *MS Word* document containing the desired test procedure, the hypertext link allows the user to print not only the *MS Word* document, but also the associated data sheets with updated test results.

Suggestions for Further Study

The proposed call out and input system requires the test engineer to print a paper copy of the individual test data sheets, enter the actual results, and then log into a PC terminal to update the data in the *MS Access* main database. Although this process may aid in progress tracking and save time when submitting the final report, it still requires a duplicate effort. The actual data must be recorded on the data sheets and then transposed into the computer database. This process may accomplished in one step by use of a palmtop computer with the necessary download connections. Investigation into the use of palmtop computers is considered beyond the scope of this project and may represent and area for further study in the near future.

Attachments: (A) Network System Configuration Diagram
(B) Instructions for Tracking Testing and Acceptance Database Model
(C) Database Model (CD ROM format)

Network System Configuration



ATTACHMENT (A)

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Instructions for Tracking Testing and Acceptance Database Model

NSRP 0534 Project 6-95-1

Prepared For:
William G. Becker
NSRP Program Manager for
Panel SP-6 Marine Industry Standards

Submitted On:
February 26, 1999

By:

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Introduction

The Test Tracking Database Model represents a sample of the capabillities of a PC-based test tracking system. The database is capable of identifying individual hull designations, test procedures, line items, and specific detailed test data. The model is comprised of sample test data for 12 test procedures chosen at random from the set of standard test procedures developed in Task 4 of this project. The database model represents 12 test procedures common to three hulls with over 200 line items, and over 4,000 specific test data points. The database model reflects approximately 10% of the total number of items comprising a standard test program. The software system is capable of creating callouts, printing reports, and updating/editing data. The following is a description of the system capabilities:

Main Menu

The Database Model automatically opens the **MAIN MENU** Screen. Figure 1 illustrates the options available from the **MAIN MENU**, each selection option is explained below.

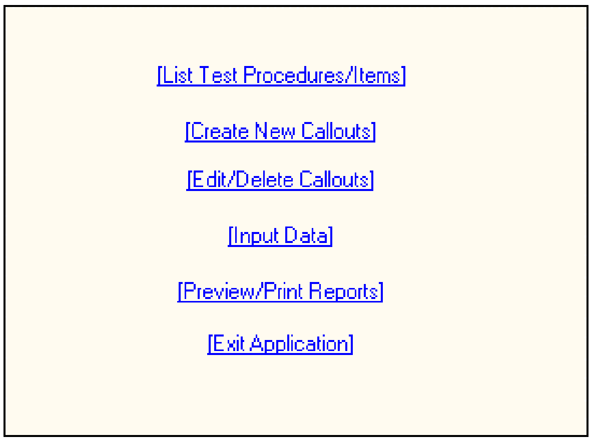


Figure 1 - Main Menu

List Test Procedures/Items

By selecting or "clicking on" **[List Test Procedures/Items]** the screen depicted in Figure 2 is displayed. The hull and test procedure selection screen contains information regarding hull number, test procedure number, description, and status. The status column indicates if the test procedure has been completed (closed), or if there are still items to demonstrate (open). The screen set up allows the user to select a specific hull number and test procedure, and then immediately proceed to the screen shown in Figure 3.

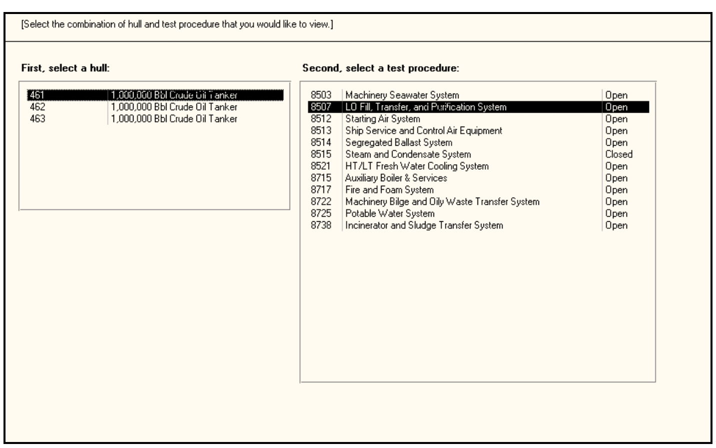


Figure 2 - Hull and Test Procedure Selection Screen

The screen shown in Figure 3 lists all line items for the selected test procedure and includes the status of each item and a check box to indicate if the item has been selected for call out. From this screen the user may “double-click” a specific line item and the details of the test data for that line item are then displayed as shown in Figure 4. Additionally, by using the navigation bar at the bottom of the screen the user may choose the **[Create New Callout]** link to go directly to the the screen shown in Figure 5 (See **Create New Callout** below). The **View Item Details** button may be used to toggle from Figure 3 to Figure 4. the **[Back]** link reverts back to the hull and test procedure selection screen (Figure 2).

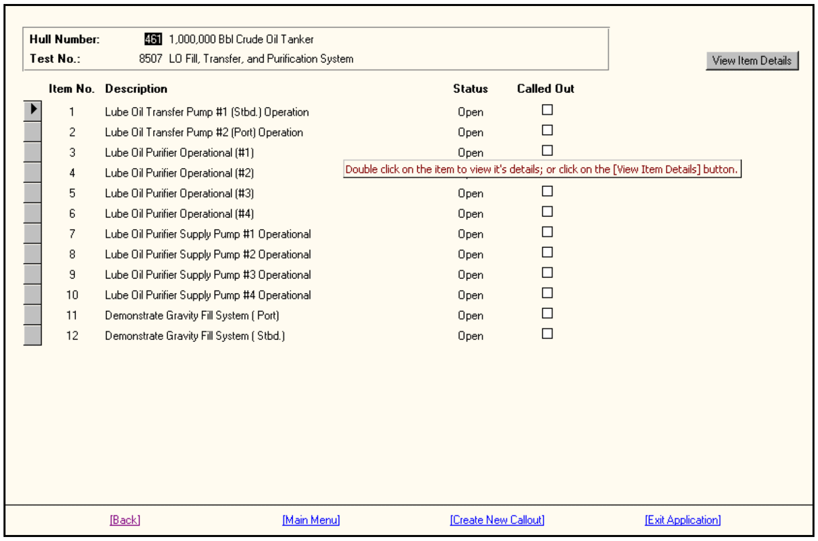


Figure 3 - Line Item Selection Screen

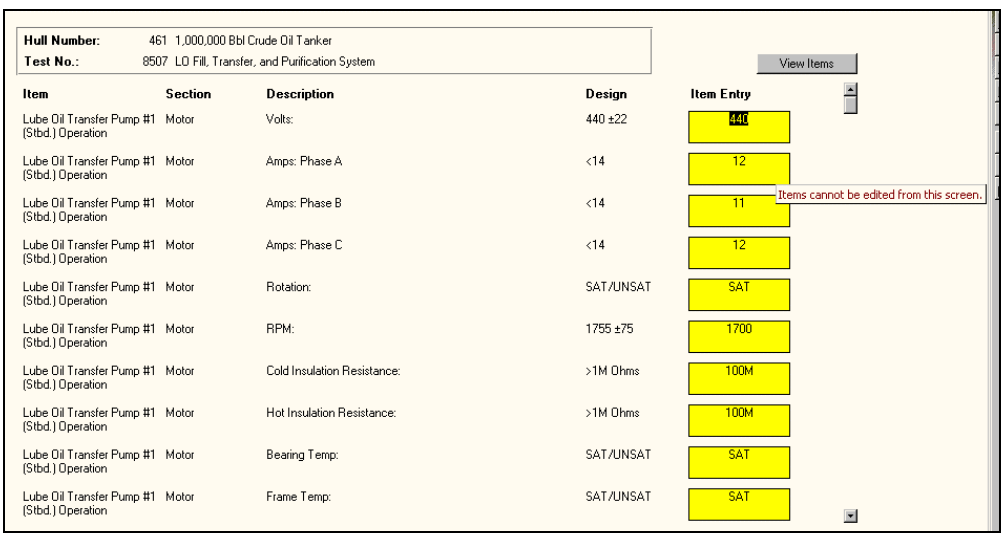


Figure 4 - Line Item Details Screen

Create New Callout

The **Create New Callout** screen as shown in Figure 5 can be accessed via the **MAIN MENU**, or via **[List Test Procedures/Items]** as described above. By selecting the appropriate hull number and test procedure number from the screen shown in Figure 5, the form depicted in Figure 6 is then displayed. The colored/shaded boxes indicate input necessary for completing a callout. After the user has completed the form and selected the appropriate line item(s) by clicking on each, he then

clicks on the **SUBMIT CALLOUT** button to add the callout to the list of existing callouts. From this screen he may then print the callout. Note: All required information on this form must be completed to submit a callout.

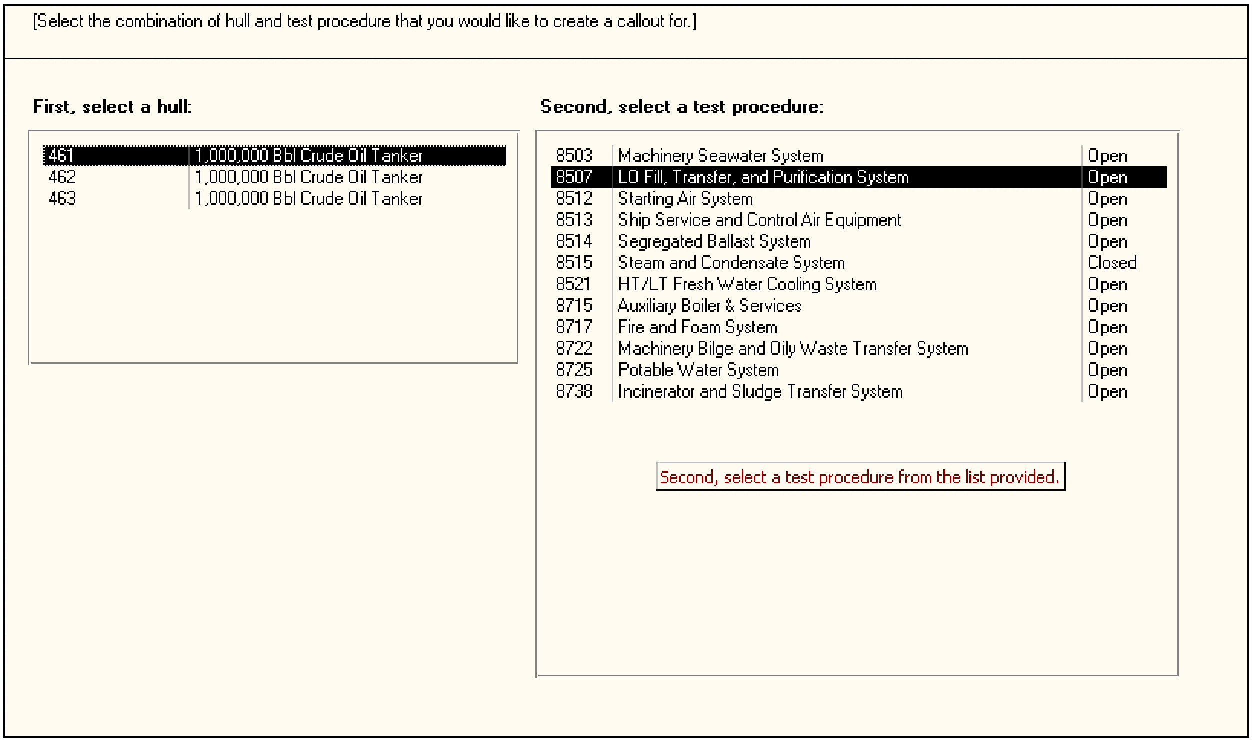


Figure 5 - Create New Callout Screen

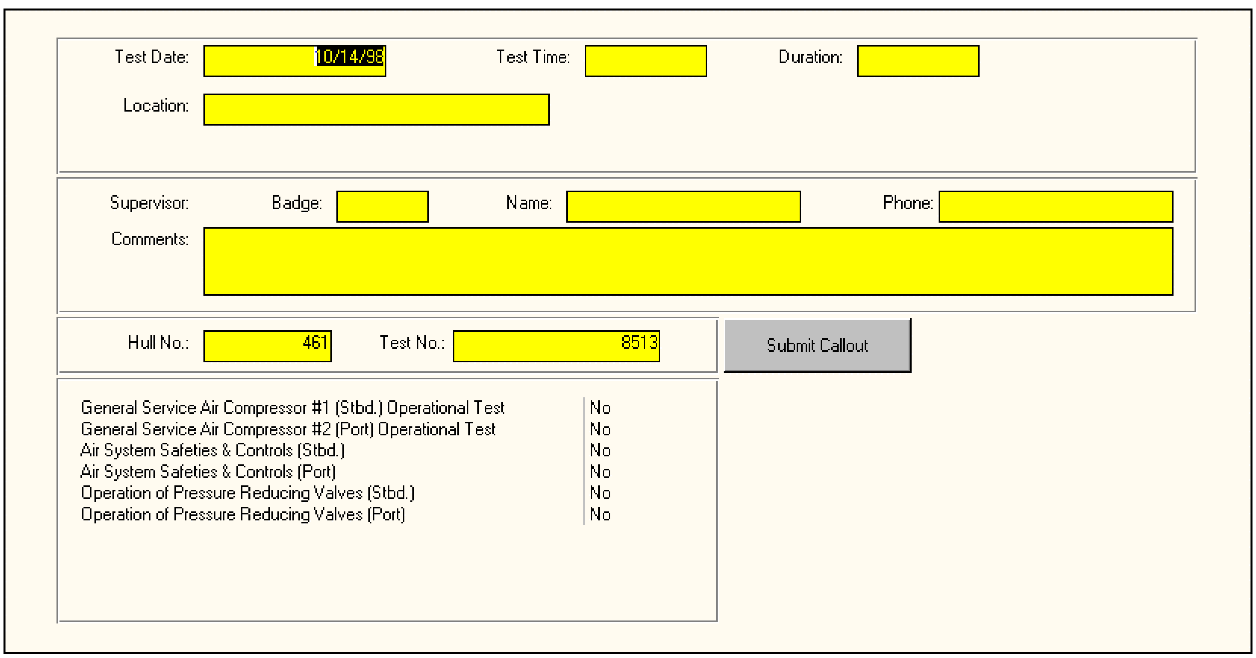


Figure 6 - Create Callout form

Edit/Delete Callouts

By selecting **[Edit/Delete Callouts]** the user is able to choose a callout to edit or delete from a list of established callouts as depicted in Figure 7. By "double clicking" on the desired callout, a completed form as shown in Figure 8 is displayed. The user may modify any information contained in the boxes, and may delete any or all line items. The form is closed by pressing the **UPDATE CALLOUT** button, and the user is given the option to print the new callout.

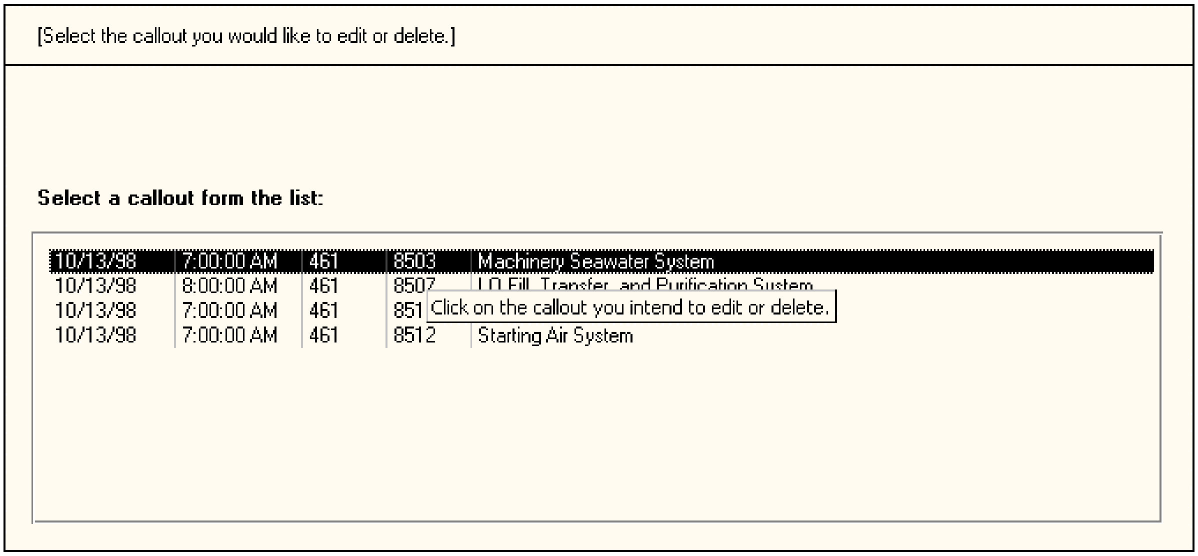


Figure 7 - Select Callout Screen

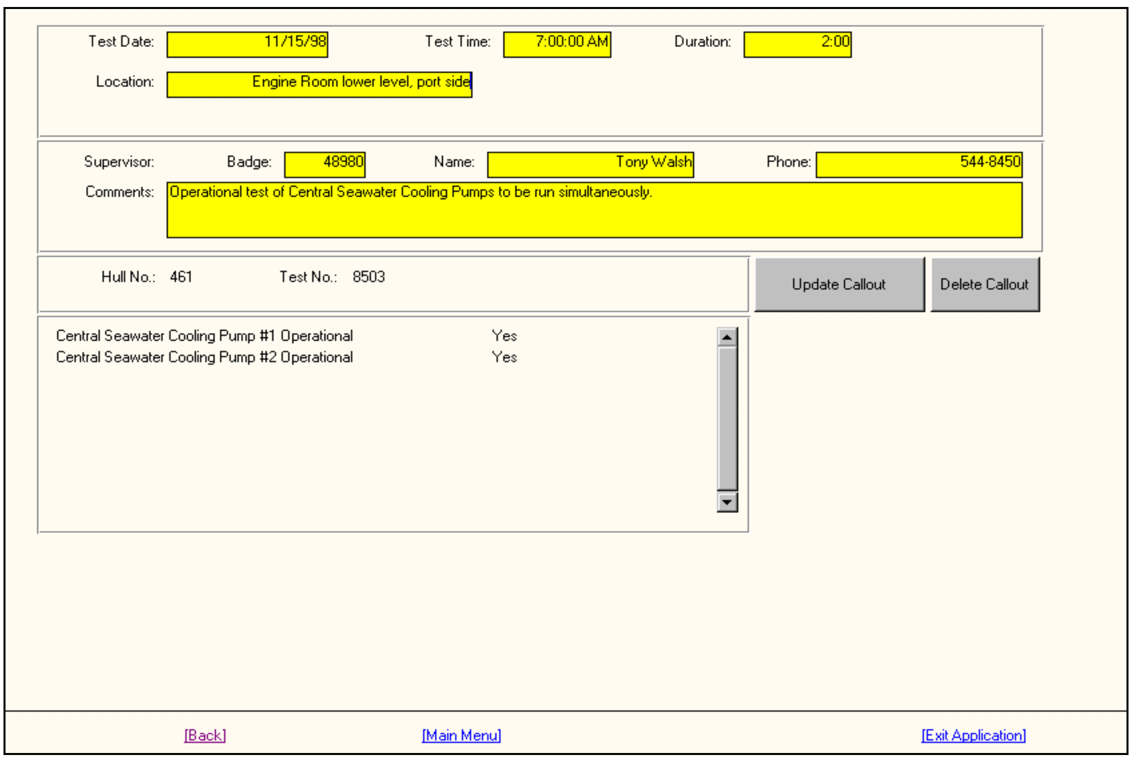
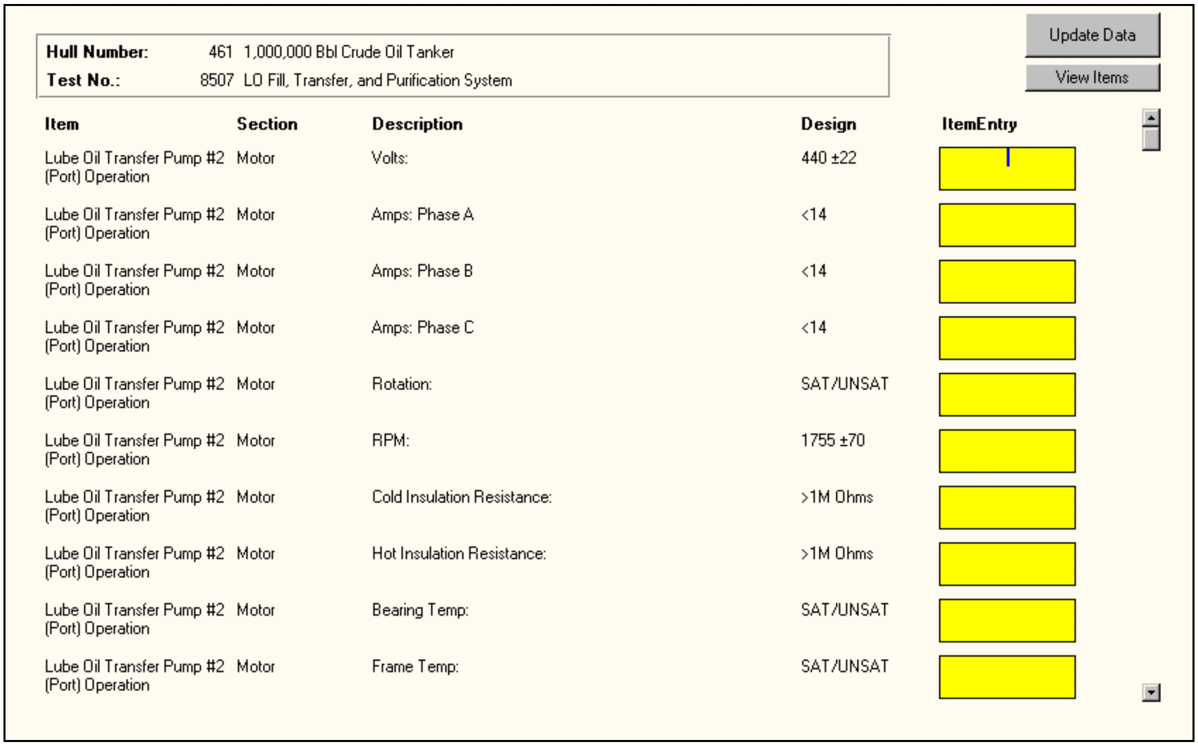


Figure 8 - Edit/Delete Callout Screen

Input data

By selecting **[Input Data]** the user is able to select any hull, test procedure, and line item from screens similar to those shown in Figures 2 and 3. Upon selection of a specific line item, the detailed data sheet is then displayed as shown in Figure 9. The user may then enter actual data obtained during equipment demonstration and testing. By pressing the **UPDATE DATA** button the information is then stored in the main database and will be reflected in any reports generated.



Hull Number: 461 1,000,000 Bbl Crude Oil Tanker
Test No.: 8507 LO Fill, Transfer, and Purification System

Update Data
View Items

Item	Section	Description	Design	ItemEntry
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Volts:	440 ±22	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Amps: Phase A	<14	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Amps: Phase B	<14	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Amps: Phase C	<14	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Rotation:	SAT/UNSAT	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	RPM:	1755 ±70	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Cold Insulation Resistance:	>1M Ohms	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Hot Insulation Resistance:	>1M Ohms	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Bearing Temp:	SAT/UNSAT	
Lube Oil Transfer Pump #2 (Port) Operation	Motor	Frame Temp:	SAT/UNSAT	

Figure 9 - Update Data Form

Preview/Print Reports

At anytime, any approved shipyard test personnel, CSARB representative, or cutomer may preveiw and print any of several reports by selecting **[Preveiw/Print Reports]** from the **MAIN MENU**, and chosing an option from the **REPORT MENU** depicted in Figure 10.

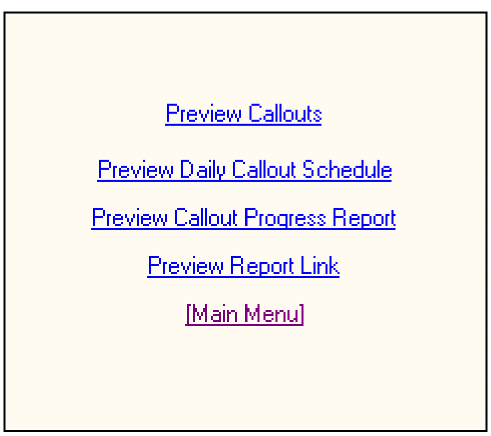


Figure 10 - Report Menu

The selections from the **REPORT MENU** are as follows:

Preview Callouts Report

To preview and/or print an established callout, select the desired callout from the screen depicted in Figure 11. A print of the callout may be used by the test engineer as an actual data sheet for the test demonstration. A sample callout data sheet is included as Attachment (1).

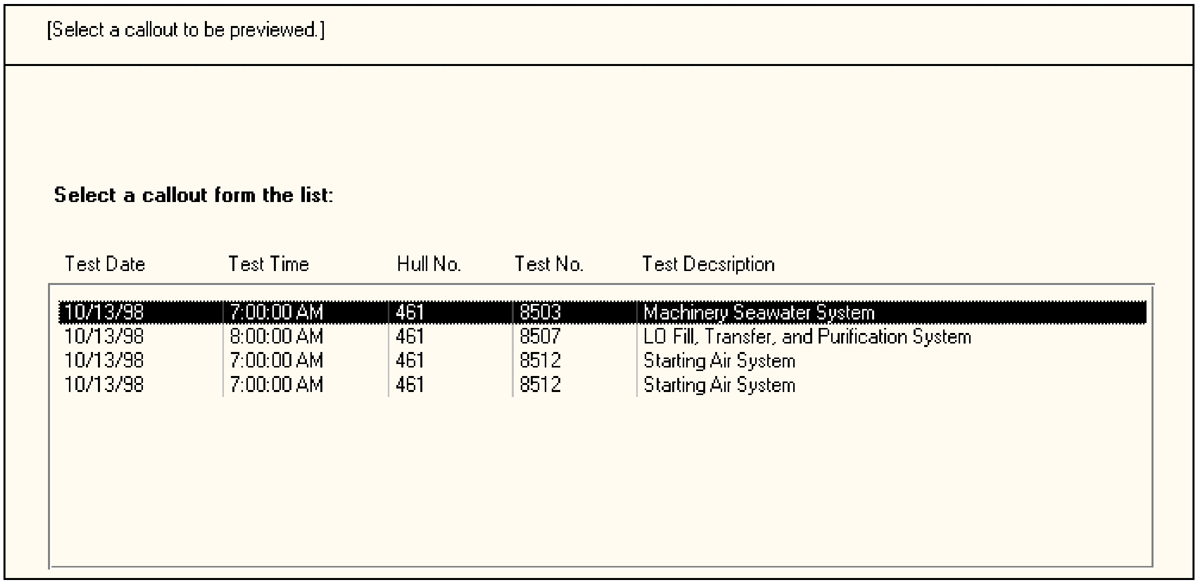


Figure 11 - Preview/Print Callout Selection Screen

Preview Daily Callout Schedule

In order to preview/print all the scheduled callouts for a certain date, select the appropriate date from the screen shown in Figure 12. A sample Callout Schedule Report is included as Attachment (2).

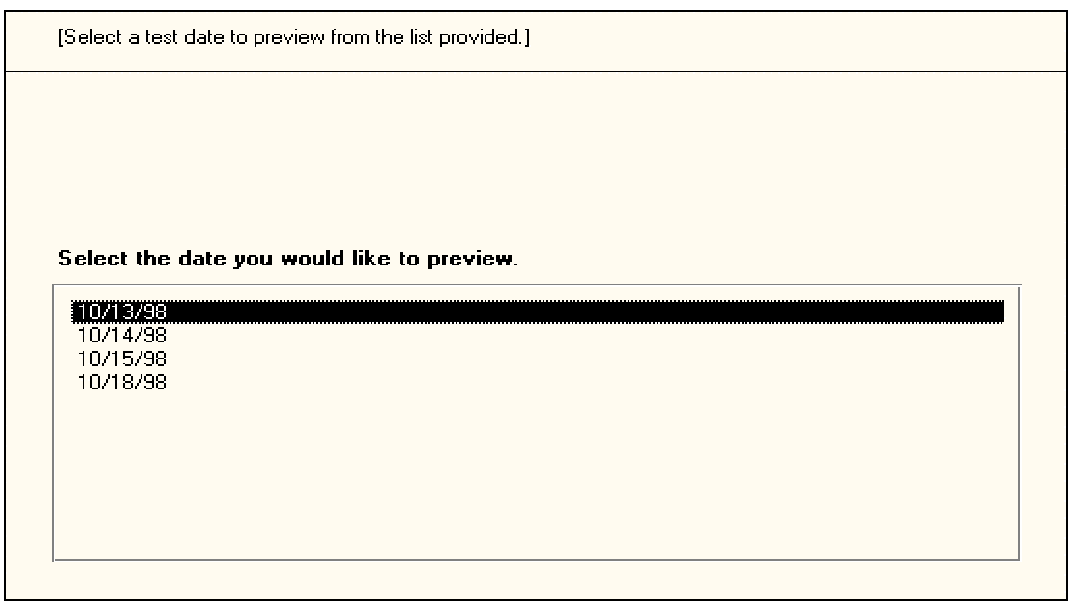


Figure 12 - Preview/Print Daily Callout Schedule Selection Screen

Preview Callout Progress Report

A Progress Report may be previewed and/or printed directly from the REPORT MENU. A sample Progress Report is shown in Figure 13.

NATIONAL SHIPBUILDING RESEARCH PROGRAM
Callout Progress Report

Hull No.: 461 — 1,000,000 Bbl Crude Oil Tanker

TP No.: 8503 — Machinery Seawater System

Item No.	Description	Status
1	Central Seawater Cooling Pump #1 Operational	Open
2	Central Seawater Cooling Pump #2 Operational	Open
3	Central Seawater Cooling Pump #3 Operational	Open
4	Prove Operation of Machinery Room Cross-Connect	Open

TP No.: 8507 — LO Fill, Transfer, and Purification System

Item No.	Description	Status
1	Lube Oil Transfer Pump #1 (Stbd.) Operation	Open
2	Lube Oil Transfer Pump #2 (Port) Operation	Open
3	Lube Oil Purifier Operational (#1)	Open
4	Lube Oil Purifier Operational (#2)	Open
5	Lube Oil Purifier Operational (#3)	Open
6	Lube Oil Purifier Operational (#4)	Open
7	Lube Oil Purifier Supply Pump #1 Operational	Open
8	Lube Oil Purifier Supply Pump #2 Operational	Open
9	Lube Oil Purifier Supply Pump #3 Operational	Open
10	Lube Oil Purifier Supply Pump #4 Operational	Open
11	Demonstrate Gravity Fill System (Port)	Open
12	Demonstrate Gravity Fill System (Stbd.)	Open

Figure 13 - Sample Progress Report

Preview Report Link

The information contained in the Test Tracking Database is also linked to each individual test procedure (MS Word documents). By printing the applicable Word document, a report is automatically generated displaying the updated test data information in report form as part of the word document. This process may be used to submit final test reports to the customer. The linked report for any test procedure can be viewed by selecting **[PREVIEW REPORT LINK]** from the **REPORT MENU**, and entering the applicable hull and test proceudre numbers. A sample report link is shown in Figure 14.

NATIONAL SHIPBUILDING RESEARCH PROGRAM

Test Procedure: 8507 | **NSRP Hull Number: 461**

LO Fill, Transfer, and Purification System | 1,000,000 Bbl Crude Oil Tanker

Item # 1 Lube Oil Transfer Pump #1 (Stbd.) Operation

Controller

Description	Design	Actual
Cold Insulation Resistance	>1M Ohms	100M
Hot Insulation Resistance	>1M Ohms	100M

Motor

Description	Design	Actual
Amps : Phase A	<14	12
Amps : Phase B	<14	11
Amps : Phase C	<14	12
Bearing Temp:	SAT/UNSAT	SAT
Cold Insulation Resistance:	>1M Ohms	100M

Figure 14 - Sample Test Procedure Report Link

Attachments: (1) Sample Callout Data Sheet

(2) Sample Callout Schedule Report

Standard Commercial Ship Test and Inspection Plan, Procedures, and Database

Task 6 - Final Report

Project 6-95-1

Prepared For:
William G. Becker
NSRP Program Manager for
Panel SP-6 Marine Industry Standards

Submitted On:
April 1, 1999

By:

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Executive Summary

The standards and specifications that the U.S. shipbuilding industry must follow are often inconsistent and sometimes inadequate. These standards and specifications are contained in numerous reference sources and are enforced by multiple regulatory bodies, classification societies, government agencies and owners. Although shipbuilding technology has continued to make significant improvements that have reduced portions of design and construction manpower requirements, one area that is contributing to expanding construction schedules and increased cost is the area of test and inspection.

Successful testing of various systems, equipment, machinery, fittings, and components is required prior to delivery of a new commercial ship. Most of these required tests are performed during the final stages of construction, on board, after launch. As with outfitting, test and inspection during the final phases of construction can be inefficient, time consuming, and costly. As a result, test and inspection can preclude attempts to reduce the duration of ship construction time.

The overall ship construction time and associated cost would be significantly reduced if the system testing were accomplished in the most efficient stages of construction, which may be either earlier or later in the build strategy. Standardized procedures for typical tests and inspections would eliminate costly owner interpretations of CSARB (classification society and regulatory body) requirements. Such standardization may also reduce the amount of repetitive testing and could be facilitated by a database that incorporates the acceptance of systems and equipments at the vendor, ground assembly, onboard outfitting, and trial stages of construction.

This project investigates existing rules and regulations for testing and inspection of commercial ships and identifies differences and similarities within the requirements. Additionally, the project poses alternate methods for test and inspection which satisfy all the various requirements and standarizes the testing function. The results include comparison matrices, a standard test plan, a set of standard test procedures, and a sample test database developed for a typical commercial ship.

Table of Contents

Task 1 - Collection and Review of Standards and Specifications

Objective

The first step of Task 1 was to compile a list of references, standards, and specifications used by domestic and foreign shipyards for certification, classification, and acceptance. The list of applicable documents is shown in Figure 1.

From the information gathered, all portions of the associated documentation that are related to shipboard testing were extracted and compiled. This information was classified into related categories as dictated by the various classification societies and regulatory bodies (CSARBs). After a review of each section, a written document identifying inconsistencies, errors, conflicts, and discrepancies was prepared. This document is considered the deliverable portion of Task 1 and is included as Attachment 1B of the complete report submitted to the NSRP.

American Bureau of Shipping	*Rules for Building and Classing Steel Vessels*
Det Norske Veritas	*Rules for Classification of Ships*
Lloyd s Register	*Rules and Regulations for Classification of Ships*
American Society of Testing and Materials	*Volume 01.07 Shipping*
Code of Federal Regulations	*46 Parts 1 to End*
Safety of Life at Sea	*Rules*
Japanese Industrial Standards	*Section F*

Figure 1 - Collection of Standards and Specifications

Approach and Rationale

Upon preliminary review of the pertinent documentation, it was apparent that no two classification societies or regulatory bodies subdivide their rules and regulations in the same way. This makes a direct comparison difficult and often misleading.

For the purposes of this exercise, the team determined that the most effective and perhaps the clearest method of comparison is to establish a baseline. The baseline represents a selected set of rules or regulations from a single regulatory body or classification society. All other rules and regulations were then compared to the baseline set to determine inconsistencies and deficiencies.

Based on the information compiled, the team selected the **American Bureau of Shipping (ABS)** - *Rules for Building and Classing Steel Vessels* as the baseline set of rules. The ABS documentation subdivides their rules into five parts, and furthermore distinguishes between testing, tests, trials, and hull test & trials. This method of subdivision along with the comprehensive testing criteria of the ABS made their rules the most desirable when establishing a baseline. See Figure 2.

Although the ABS Rules were found to be the most comprehensive, there are certain systems or equipments for which the ABS Rules have no specific testing requirements. To supplement the ABS Rules, the requirements for testing of these systems and equipments covered by documentation from other regulatory bodies other were included in the comparison.

Additionally, while all sections pertaining to testing, trials, and inspection were reviewed, not all sections were applicable to the project. Certain areas which deal only with manufacturer's testing, first article testing, component testing, in-service or periodic testing, and quality inspection were not considered germane to this project. The focus of this exercise was to compile information (rules and regulations) governing system testing, trials and inspection. Therefore more emphasis has been placed on those sections which pertain to system testing.

It should also be noted that the Society of Naval Architects and Marine Engineers (SNAME) Technical and Research Bulletins 3-47 *Guide for Sea Trials* and 3-39 *Guide to Shop and Installation Tests* were not considered applicable to this project. Although the SNAME documentation is relevant to the project, SNAME is not considered a regulatory body or a classification society, and therefore the information contained in the Technical and Research Bulletins is not included in the comparison matrix. The same is true for the American National Standard Institute (ANSI) -

IEEE Recommended Practice for Electric Installations on Shipboard, and also holds true for the International Electrotechnical Commission (IEC) - *Electrical Installations in Ships, Part 401 Installation and Test of Completed Installation*.

Findings

As the first step toward identifying differences between regulatory body requirements, a matrix was created. The matrix compares stated test requirements of CSARBs with regard to categories based on ABS suggested subdivisions. The matrix is subdivided into approximately 72 categories. Of these 72 categories, 35 categories had CSARB references which were applicable to our project. These 35 groups make up the working portion of the matrix and are listed on the first 3½ pages of the matrix. The remaining 37 categories had references pertaining only to first article or manufacturer testing. These headings are grouped together at the end of the matrix in the shaded areas and were not used in the comparison. In a parallel effort to the matrix review, copies of the matrix were forwarded to representatives from the applicable classification societies and regulatory bodies. Their input, as appropriate is included in the matrix. The matrix was considered a working document and a copy is included as Attachment 1A of the complete report submitted to the NSRP.

Results

The initial review of the test requirements of the various CSARBs revealed that the differences between the requirements is not as extensive as the team had originally expected. There are many areas where one classification society or regulatory body appears to take on the lead role in development of a test standard. Conversely, there are certain categories of testing in which certain CSARBs have no clear testing requirements.

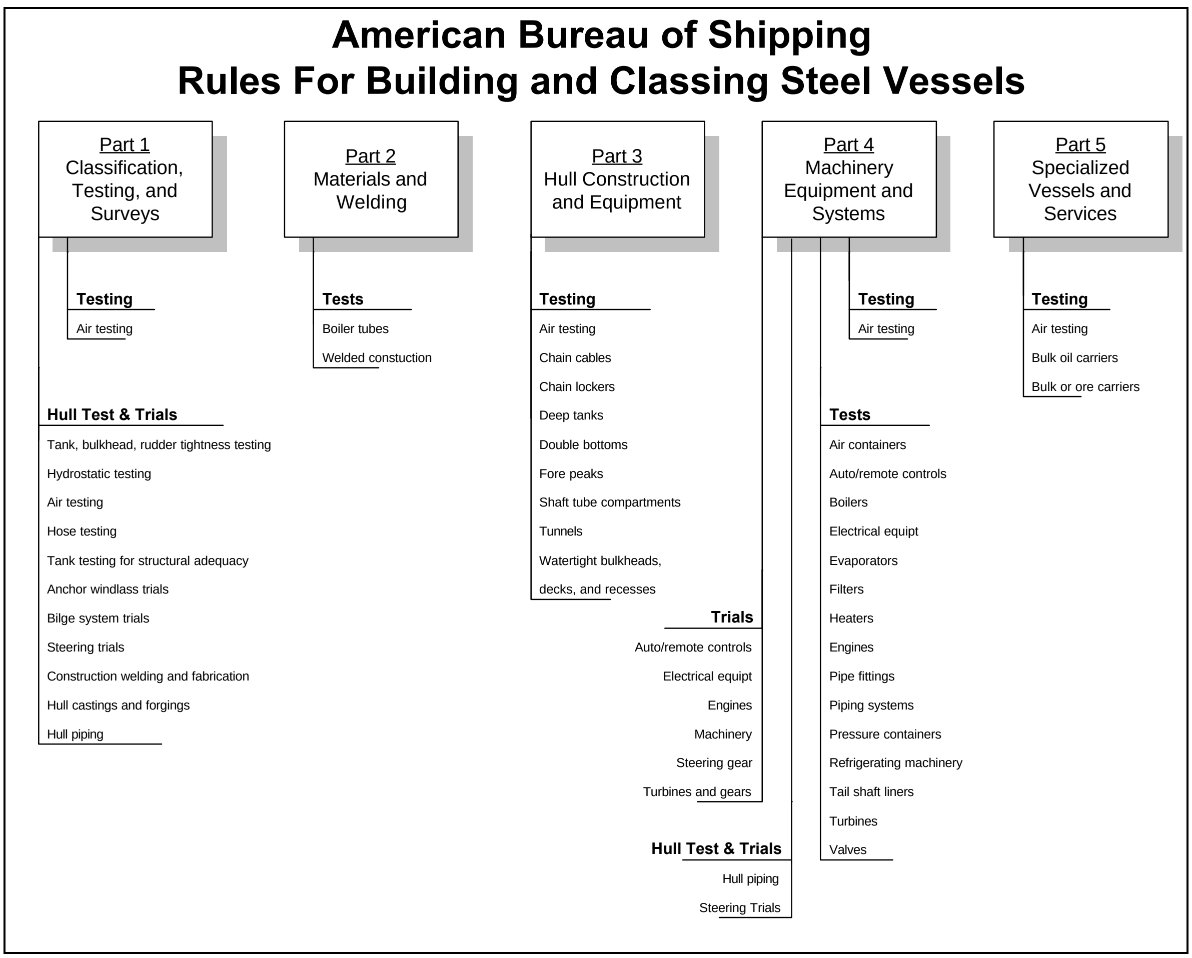

Figure 2 - Subdivision of ABS Rules

Applicability to Other Tasks

The documents developed in Task 1 served as a guide for determining regulatory barriers that restrict testing to specific phases of construction, a consideration in Task 2. The documents were also used as a reference guide for the development of the Standard Ship Test and Inspection Plans and Procedures of Task 3.

Task 2 - Factors to Determine Testing at the Optimal Stages of Construction

Introduction

The information compiled in Task 1 provided a useful foundation upon which an effective test plan and test procedures can be developed. However, to further define a commercial standard test plan and test procedures, it was also necessary to look at the factors which influence test programs. These factors include current industry practices regarding testing, and Classification Society and Regulatory Body (CSARB) rules that create barriers restricting testing to specific phases of construction. The focus of Task 2 was to investigate these factors and determine the most efficient testing methods within the parameters set forth by the CSARBs.

Objective

The Regulatory Body Test Requirement Matrix developed in Task 1 compared and contrasted the worldwide regulatory bodies requirements for testing a commercial ship. The team found that while each varied in their approach to ship testing, the overall result of testing a ship was fairly similar. However, the ABS breakdown structure, as well as the other CSARB structures, do not effectively parallel a systems breakdown for a commercial ship. Task 2 investigated the typical systems found on a commercial ship and identified the optimum stages of construction for testing. Once compiled and analyzed, this information was utilized in writing the standard test plan and test procedures necessary to accomplish Task 3.

The feasibility of testing each system in the optimum stage of construction (earlier or later in the construction plan), is based on the following factors:

- CSARB barriers restricting testing to specific phases of construction.
- System design issues that require certain portions of systems to be completed prior to testing such as piping, alignments, electrical wiring, etc.
- Documentation requirements of CSARBs for incremental testing and final acceptance.

Approach and Rationale

In order to better analyze system testing requirements, the project team identified a list of representative systems found on a typical commercial ship. Attachment 2A of the complete report, entitled *System Testing and Inspection Requirements,* represents a comparative analysis of the pertinent system test requirements. The descriptive breakdown of each system reflects those factors that determine the extent and timing of testing.

The *Comments* section of each page identifies the types of tests and inspections performed by other shipyards currently building commercial ships worldwide. A separate Test Procedure Comparison Matrix, included as Attachment 2B of the complete report, was created to quickly compare what types of testing are accomplished by each representative yard. This information was then transcribed into the C*omments* section of each system.

The *Recommendations* section of Attachment 2A identifies the team's recommendations as to which types of tests, if any, are needed to satisfy all CSARB requirements for a particular system. Based on the information gathered, recommendations to include certain tests, and to move other tests to in-process inspections, were made. This information was the basis for the development of the test plan and test procedures in Task 3.

To further define the specific system design issues influencing testing, Gantt charts were developed. The Gantt charts, included as Attachment 2C, outline major phases of vessel construction and represent the interrelationship between major testing evolutions. The ship systems were grouped into larger classifications, from which the Gantt charts were created. The top two lines of each Gantt chart contain the ships' milestones and key dates. The milestones

show major ship evolutions that pertain to ship testing while the key dates show the various phases of construction. The milestones chosen were as follows:

- Launch or Undocking of the ship,
- Shore power to the switchboard,
- Emergency Diesel Generator start,
- Main Diesel Generators start,
- Inclining Experiment,
- Dock Trials,
- Sea Trials, and
- Delivery.

The key dates identified show four phases of ship construction:

- Steel assembly,
- On-ground or on-unit outfitting,
- On-board outfitting, and
- Test.

Findings

From the information collected during the research efforts of Task 2, recommendations with regard to specific system and component testing were suggested. Considering the CSARB requirements and applicability of testing during certain phases of construction, suggestions to include certain tests or to move other tests to in-process inspection were made. The team developed a test plan and a set of test procedures that reflect these findings.

Task 3 - Standard Ship Test Plan

Introduction

The intent of this project was to investigate and evaluate testing requirements and test criteria as outlined by the Classification Societies and Regulatory Bodies, and to develop a mutually agreeable test program to include a test plan and test procedures. Conversely, the purpose of this project was *not* to evaluate all production processes and inspection activities required for ship construction. The team maintained a focus on system testing plans and procedures in an effort to better understand and coordinate the intentions of the CSARB.

Objective

The focus of Task 2 was to identify CSARB restrictions to testing during certain phases of construction, and establish a test schedule that satisfies the requirements and restrictions of the CSARB.

The Test Plan developed for Task 3 is comprised of the documentation, processes, and measures used to effectively test, inspect, and commission a new vessel. Additionally, the Test Plan represents general provisions related to testing, the relationship of testing to ship construction, and the need for special ship conditions and test equipment.

Approach and Rationale

Through a review of current commercial ship test plans and visits to various shipbuilding facilities, the team developed a document which incorporates aspects of test plans throughout the industry. The Test Plan reflects current industry methods with respect to testing and trials and can be considered a *Standard Test Plan* because it satisfies all the CSARB requirements.

The *Standard Test Plan* developed for this project is comprised of several general sections which outline provisions for testing. These general sections apply to all ship types and classes. In addition to the general provisions, the *Standard Test Plan* also includes a detailed Shipboard Installation Test section. This section describes in detail the extent of testing required for each system and associated system components. The systems included in the *Standard Test Plan* presented herein are representative of common systems found on most vessels. In order to further understand the scope of the Shipboard Installation Tests, the systems common to a medium sized crude oil carrier were used as a baseline.

For the purposes of this exercise, the *Standard Test Plan* includes shipboard installation tests, commissioning test procedures, dock trials, and sea trials. Flushing of piping and piping systems is addressed as part of the Quality Plan; however, hydrostatic testing of piping and piping systems is included in the *Standard Test Plan*. The Quality Plan includes all production processes, acceptance criteria, control group authority, and production department responsibility.

Sources

Sample Test Plans evaluated for this exercise were obtained from the following shipyards:

- National Steel and Shipbuilding Company
- Newport News Shipbuilding
- Hyundai Heavy Industries
- Avondale Industries
- Kawasaki Heavy Industries

As a rule, Test Plans are not generally used in European shipyards. Based on the results of a trip to Northern European shipyards, the project team determined that the information contained in their shipbuilding specification takes the place of separate Test Plan documentation. It is important to note that the shipbuilder and the owner/customer reach a mutual agreement as to the test requirements, and as to which document outlines these test requirements.

Supplemental Test and Inspection Requirements

The Standard Test Procedures developed in Task 4 include specific test criteria, expected values and allowable tolerances generated from system diagrams, cognizant engineer input, and vendor technical data. Where the Standard Test Procedures are lacking this information, the supplemental criteria is outlined in a document known as *The Supplemental Test and Inspection Requirements.* This document is included as Attachment 3B of the complete report.

The Supplemental Test and Inspection Requirements document is designed for use on commercial contracts only, and addresses test and inspection requirements for equipment and systems operational testing during construction and trials.

Results

The *Standard Test Plan* not only represents a cross section of current industry practice, but also complies with the CSARB requirements. With slight modification to the specific Shipboard Installation Tests, the *Standard Test Plan* can be used to effectively outline testing to be accomplished for any commercial vessel, built to any Classification Society Rules.

Applicability to Other Tasks

The information contained in the *Standard Test Plan* was used to develop the test procedures required for Task 4. The *Standard Test Plan* clearly defines the roles of the various departments involved in the test and trials process. Based on the information in the *Standard Test Plan,* a *Standard Test Procedure Format* was developed. The new *Standard Test Procedure Format* is simple, and streamlined, and reflects the current world shipbuilding methodologies. The general provisions in the *Standard Test Plan* replace information traditionally contained in the Test Procedures, and allow the *Standard Test Procedure Format* to be as general as possible. The descriptions given in the Shipboard Installation Test Section form the basis for each system Test Procedure and, coupled with the technical manual documentation, provide sufficient instruction to carry out the testing requirements.

Task 4 - Standard Ship Test Procedures

Objective

The Test Plan developed for Task 3 is comprised of the documentation, processes, and measures used to effectively test, inspect, and commission a new vessel. The Test Procedures developed for Task 4 identify the requirements set forth by the CSARBs which are used to set-up, start, and demonstrate satisfactory operation of the ship equipment and machinery.

Like the Test Plan, the Test Procedures are based on a medium-sized crude oil tanker. The sample set of Standard Test Procedures developed are *standard* in that they satisfy the all the CSARB requirements. The set of Standard Test Procedures in the form presented herein do not apply to all ship types. To develop a set of Standard Test Procedures that would be suitable for use on all types and sizes of vessels would be impossible.

Approach and Rationale

Through a review of current commercial ship Test Procedures and visits to various shipbuilding facilities the team developed a set of Test Procedures which represent the current industry trends. The total quantity of Test Procedures has been reduced 25 percent from the quantity traditionally used by a U.S. shipyard Test Program.

The format of each individual Test Procedure was modified to reflect methods used in other countries. Most Test Procedures are comprised primarily of data sheets which identify expected (design) results but do not contain extensive

system operational information. Necessary system or equipment operational information is obtained from the associated technical manuals and system diagrams. Test Procedure details outline the test requirements thereby identifying only what is to be demonstrated. The scope of the proposed Test Procedure format has been greatly reduced and does not give detailed descriptions of system set-up or equipment operation (see Figure 3). It is up to the individual Test Engineer to determine the most effective method of demonstrating the required system parameters and capabilities. By allowing the Test Engineer the freedom to conduct, coordinate, set-up, and demonstrate the system capabilities testing will be most effectively accomplished.

Sources

Sample Test Procedures evaluated for this exercise include have been obtained from the following shipyards:

- National Steel and Shipbuilding Company
- Newport News Shipbuilding
- Hyundai Heavy Industries
- Avondale Industries
- Kawasaki Heavy Industries
- Other Northern European Shipyards

Results

The set of Standard Test Procedures compiled represents approximately 50 percent of the total quantity of test procedures required for a complete Test Program. Systems common to most ship types have been selected to present a good cross-section of test requirements, and test procedure development characteristics. The Test Plan submitted in Task 3 lists all the required test procedures for a complete Test Program.

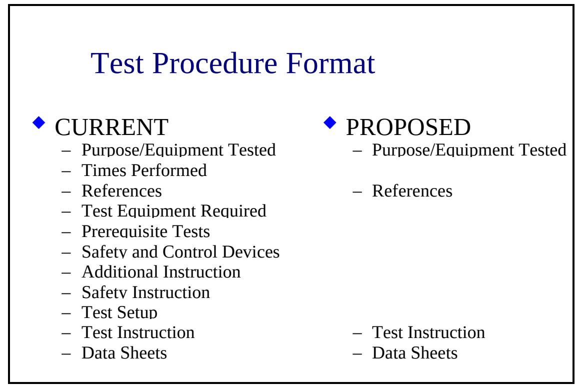

Figure 3 - Test Procedure Format Comparison

Trip Reports

Approach and Rationale

To better understand the current industry practices regarding testing and inspection the project team visited foreign shipyards to witness their testing programs. Through a review of current commercial ship test plans and visits to the various shipbuilding facilities the team gained an understanding of the worldwide standard of ship testing requirements.

Shipyards Visited

The project team visited three Northern European shipyards, and although each shipyard is building a unique product, there exists many processes and procedures with respect to testing which can be considered common.

Detailed Trip Reports outlining the findings of these visits are included as Attachments R1, R2, & R3 to the complete report.

Findings

The following summaries serve to highlight the key similarities and differences discovered by the project team.

Test Organization

The Test Engineering function at all three shipyards is integrated into the Design and Production Departments, known commonly as the *Commissioning Department.* This independent group performs, and often writes the test procedures. Additionally, all three shipyards benefit from extensive vendor participation in the test and commissioning process. Generally a manufacturer’s representative will accomplish

most of the start-up procedures for major components (per purchase agreement).

Design/Test Interface

Advanced planning for partial testing, or incremental testing is not prevalent. Incremental testing is not planned nor accomplished. The only example of design for testing that was discovered was the design addition of temperature and flow nozzles for sea trial measurements.

The Design Departments are generally responsible for miscellaneous vibration, noise, and maneuvering and speed trials testing. The Design Departments are also responsible for obtaining technical information required for testing from the vendors and regulatory bodies.

Test Procedure Format

As a general rule our European counterparts tend to keep the scope and content of their Test Procedures written as vague as possible. The Test Procedures contain data sheets, not detailed test instructions. Occasionally, a one or two paragraph description of the test instruction and set-up are included. The total quantity of Test Procedures is also considerably less than a typical U.S. test program.

Test Procedure Development

Typically Test Procedure development starts with the basic information from a previous contract (baseline). However, each shipyard has a different group responsible for writing Test Procedures. Often test procedures are written by Design Groups or Commissioning Engineers. Other times the test procedures are written and performed by the Quality Assurance group, including subcontractor tests.

Production Interface

In all three shipyards visited only minimal testing is done during the early outfitting stages or prior to launch. The team did not witness any pre-assembly, on-unit, or on-block testing. Partial system testing is not done, only complete system testing in the later stages of construction is accomplished. The team did not see any special fixtures or jigs made specifically for testing.

Factory testing is considered very important and is usually witnessed by a Commissioning Engineer or Shipyard Quality Assurance Representative. However, the shipyards do not rely on factory testing only. Components tested under factory test conditions are also verified under shipboard conditions to ensure reliability at sea trials. Heat runs on motors in addition to the factory heat runs are not required and are generally not done.

Pipe Hydrostatic testing

Hydrostatic testing is not outlined in a Test Procedure, the hydrostatic testing requirements are contained in a separate booklet. Hydrostatic testing is generally not done on partial systems, and is usually accomplished as a complete system test onboard. Joints are left unpainted prior to test in some shipyards, painted in others. System piping diagrams are marked as the hydrostatic testing is completed by the Production Department as a means of tracking completion progress.

Test Plan and Schedule

The Test Plan commonly used by U.S. and Asian shipyards does not exist in the three shipyards visited. Similar information is contained in the shipbuilding specification, and therefore a separate document is not required.

The Test Schedule and Sea Trial schedule are usually developed by the Commissioning Department. Testing duration is not standard and ranges from 3.5 weeks to 12 weeks. The duration of sea trials can last anywhere from an 18 hours, to six days.

Classification Society, Regulatory Body and Customer Requirements

The project team did confirm the existence of a set of *Standard Test Procedures* satisfying multiple CSARB requirements. This finding is directly related to the development of the *Standard Test Procedures* for Task 4. As the team had predicted, the *Standard Test Procedures* satisfied the requirements of multiple CSARBs, yet were applicable only to a specific ship type.

Two examples of a *Standard Test Procedures* were cited. In one case a ship design and test program developed using Lloyd's Rules was also acceptable to DNV for follow-ships of the same design. In a similar case, a ship design and test program developed using Lloyd's Rules was accepted by the ABS for the later ships of the class.

In all the shipyards visited it was stated that the Owner /Customer has minimal input into the test procedure development process. Generally if the shipyard has satisfied the requirements of the CSARBs, and has fulfilled the shipyard's own self-imposed test requirements, the Owner/Customer is satisfied

Documentation and Software

The project team did not witness the use of any specialized software for computer tracking or test procedure call-outs. Moreover, Test Procedure call-out systems are generally not computerized. Notice of testing is given to the customer or surveyor via phone or fax.

With regard to test procedure completion tracking (progress), all test procedures are weighted evenly.

As previously stated, factory testing is considered very important and vendors must provide factory test results to the shipyard.

Results

Based on the information gathered during the Northern European trip, and information from previous trips to Asian shipyards the project team developed a set of *Standard Test Procedures.* These Test Procedures, developed for Task 4, reflect the current industry trends in several ways:

- There is a reduced quantity of test procedures and subdivisions (line items).
- The new test procedures are *Standard*, and satisfy the requirements of all the CSARBs.
- Additionally, the new test procedures are modified to reduce the scope and to outline only test requirements and expected results. Test set up and test instruction is no longer included.
- The new test procedure format allows the production test engineers to provide the necessary expertise to operate the equipment in such a way as to demonstrate the required test parameters.
- There is an increase in vendor involvement in the testing program.
- The new test procedure format includes only the following categories:
    - Purpose/Equipment Tested
    - References
    - Test Instruction
    - Data Sheets

Projected Benefits

Implementation of the test procedure format modifications will reduce cycle time for testing, decrease redundant testing, decrease test related design effort and rework, and give production test engineers (commissioning engineers) control of test operations to utilize the most efficient methods available.

Task 5 - Database for Tracking Testing and Acceptance

Nomenclature

Badge - The employee identification number of the individual responsible for coordinating a test demonstration.

Call out - The documentation associated with a test demonstration. Information regarding location, test supervisor, time, etc. is included, as well as the specific line items to be demonstrated. Data sheets for the specified tests are also considered part of the *call out.*

Closed - A line item or test procedure is considered *closed* when it has been successfully demonstrated.

Data point - The individual pieces of information recorded at the test demonstration are considered data points. Line items may be made up of one or more data points.

Data sheet - The portion of the test call out used for recording actual results is known as the data sheet.

Database - A series of related tables used to store all information regarding the test and inspection program including; hull designation, test procedures, line items, actual and expected data points, and call out progress reports.

Design results - The expected outcome of a test demonstration based on the system diagram, vendor information, or other source. Can be quantitative or qualitative (SAT/UNSAT).

Form - A display screen which prompts the user to enter certain required information necessary to accomplish the desired task (create call out, update data, etc.).

Input - To complete the data sheets by entering actual test results in the appropriate spaces.

Line item - The portion of a test procedure that defines the actual test demonstration. The line item may represent a single data point, or multiple related data points.

Navigation bar - The lower portion of a screen which contains links to direct the user to other associated screens or back to the main menu.

Open **-** A line item or test procedure is considered *open* when it has not yet been successfully demonstrated.

Report link **-** The associated updated data sheets for a test procedure. The test procedures, developed in *MS Word*, contain icon symbols (*report links*) which link the user to the associated data sheets.

Screen **-** The display of any information related to the *MS Access* database.

Test procedure **-** An *MS Word* document comprised of the requirements and instructions used to set-up, start, and demonstrate satisfactory operation of ship equipment, systems, and machinery to the customer and CSARBs.

Test report **-** A test procedure which has been executed and contains the appropriate updated data and necessary information to be considered complete is designated a *test report*. The *report link* embedded in the test report (*MS Word* document) automatically prints the associated updated data sheets for the specified test report.

Update **-** After the user has input the actual test results, the *Update Button* allows that information to be submitted to the database.

Objective

The objective of Task 5 was to develop a model database tracking system that can be used to track the status of each standard test procedure and vendor test procedure. The database is capable of providing updated progressing of incremental and complete testing and acceptance of shipboard systems and equipment.

Additionally, the database can be used to automate test call out of any line items for witnessing of test performance by the customer or surveyor. The system allows users to make notification of their intentions to perform a test, record the results of the test, document the test in a test report, and track the progress of each test procedure.

The structure of the *Database for Tracking Testing and Acceptance* allows complete integration of all test documentation, call outs, data recording, and report generation. The use of compatible software greatly reduces duplicate effort traditionally associated with test documentation and tracking.

Approach and Rationale

Using other shipyards both foreign and domestic as a benchmark, the project team examined several different types of test programs. Each shipyard investigated utilizes computers to various extents for tracking testing. The project team incorporated the information gained from industry leaders into the development of the database for Task 5.

Software Selection

The Database for Tracking Testing and Acceptance utilizes the *Microsoft Office Professional 97 Suite* software. Specifically, the Main Database is compiled in *MS Access*, the Test Procedures are written in *MS Word*, and the forms and reports generated are a function of *MS Access and MS Word*.

The *Microsoft Office Professional 97 Suite* is a powerful tool that is readily available, and therefore is an excellent choice for *The Database for Tracking Testing and Acceptance*. The *Microsoft Office 97 Suite* is well suited for use with a PC based computer network. Unlike mainframe systems, the PC based tracking system described herein is easily modified, and can be easily upgraded.

Network System Configuration

The Database for Tracking Testing and Acceptance utilizes a PC based computer network with available terminals in key locations for end users. A generic network system configuration is depicted on Attachment 5A of the complete report.

Initial Database Input **-** Individual test procedure data sheets, line items, and data points are developed in the Main Test Database. The information contained in the database is accessible through a PC network connection. Test procedures are developed using a combination of *MS Word* and *MS Access* software to avoid duplication of effort when loading information into the Main Test database. Tables and reports constructed in *MS Access* are easily imported to *MS Word*, and included as part of the test procedures, developed in *MS Word*.

Network Connection **-** Using any existing PC network, remote PC terminals are placed in convenient locations throughout the shipyard. The test supervisors can log on to any PC

terminal to schedule a test call out, print reports, or update test procedure data.

Customer and Regulatory Body **-** In addition to the remote PC terminal accessible to the test supervisors, PC terminals are also available to the customer and CSARB surveyors. From these terminal locations the surveyors may access all information contained in the database, and may preview and print all reports.

Database System Structure

The *Instructions for Tracking Testing and Acceptance Database Model,* as well as a CD ROM containing the Database Model are included with the complete report (Attachments 5B & 5C). The following is a brief description of the system structure and capabilities.

Main Test Database **-** The main test database is developed in *MS Access*, and contains relational databases necessary for tracking, progressing, and calling out test procedures. The relational databases are comprised of all the fields required to input and update expected and actual test results. Individual records in the relational databases represent unique line items for the associated test procedures.

Individual Test Procedure Line Item Call Out- End users have the ability to select individual line items from test procedures and schedule call outs for test demonstration. Upon completing the forms associated with the main database the user may submit the scheduled call out and print a hard copy of the data sheets to record the actual results during the demonstration.

Daily Customer Call out Report **-** The customer and CSARB surveyors may access any of the reports available in the database system. A preview/print of the call out report identifies which line items are scheduled for demonstration on future dates.

Data Input **-** During the test demonstration the test supervisor records the actual test results on the test call out data sheets. This information is later input into the main database thereby keeping the database updated.

Test Procedure Progress Report **-** At any time, any authorized user of the system can preview/print a progress report. The progress report details which line items have been satisfactorily demonstrated, and which items remain open.

Database / Test Procedure Interrelationship

Test Procedures **-** Individual test procedures are developed in *MS Word* using the standard test procedures of Task 4 as a base. Each test procedure is modified slightly to suit the specific equipment in the associated design. The data sheets for each test procedure are compiled by entering the line item, data points, and expected results into the *MS Access* main database. A hypertext link embedded in each test procedure automatically displays/prints the associated data sheets for the specified test procedure. The data sheets are identical to the call out data sheets used by the test supervisor for recording the actual data during the test demonstration.

Final Test Reports **-** The main database is consistently updated and reflects both expected values and actual results. By simply opening the *MS Word* document containing the desired test procedure, the hypertext link allows the user to print not only the *MS Word* document, but also the associated data sheets with updated test results.

Suggestions for Further Study

The proposed call out and input system requires the test engineer to print a paper copy of the individual test data sheets, enter the actual results, and then log into a PC terminal to update the data in the *MS Access* main database. Although this process may aid in progress tracking and save time when submitting the final report, it still requires a duplicate effort. The actual data must be recorded on the data sheets and then transposed into the computer database. This process may accomplished in one step by use of a palmtop computer with the necessary download connections. Investigation into the use of palmtop computers is considered beyond the scope of this project and may represent and area for further study in the near future.

Additional copies of this report can be obtained from the National Shipbuilding Research and Documentation Center:

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